Missouri Department of Natural Resources
Water Pollution Control Program

Total Maximum Daily Load (TMDL)

For

The Elk River Basin

McDonald, Barry and Newton Counties, Missouri
Benton County, Arkansas

Completed: January 30, 2004
Approved: March 26, 2004

Table of Contents

Index of Tables and Figures

Figures **Page**

Phased Total Maximum Daily Loads (TMDLs)
For Waterbodies in the Elk River Basin
Pollutant: Nutrients

Waterbodies Addressed by the Elk River TMDL:
Elk River
Big Sugar Creek
Little Sugar Creek
Buffalo Creek (Two Segments)
Patterson Creek
Indian Creek
Middle Indian Creek (Two Segments)
South Indian Creek
North Indian Creek

Location:
McDonald, Barry and Newton Counties in Missouri

Hydrologic Unit Code (HUC):
11070208

Table 1: Stream Segments Included in the Elk River TMDL

Stream Name	Water body ID	Location From – To	Miles	Beneficial Uses	Stream Classification
Big Sugar Creek	3250	Sec34,T22N,R32W–Sec27,T21N,R29W	31.0	1,2,3,4,6,7	P
Buffalo Creek	3269	Sec9,T22N,R34W–Sec5,T23,R33W	10.0	1,2,3,4,5,6,7	P
Buffalo Creek	3273	Sec5,T23N,R33W–Sec14,T24,R33W	5.5	1,2,3,4,6,7	P
Elk River	3246	Sec21,T22N,R34W–Sec34,T22N,R32W	21.5	1,2,3,4,6,7	P
Indian Creek	3256	Sec1,T21N,R33W–Sec24,T24N,R31W	26.0	1,2,3,4,6,7	P
Little Sugar Creek	3249	Sec34,T22N,R34W–Sec34,T21N,R31W	11.0	1,2,3,4,6,7	P
Middle Indian Creek	3262	Sec16,T24N,R30W–Sec12,T21N,R30W	3.0	2,3	C
Middle Indian Creek	3263	Sec7,T24N,R30W–Sec16,T24N,R30W	2.5	2,3	P
North Indian Creek	3260	Sec24,T24N,R31W–Sec36,T25N,R30W	5.0	2,3	P
Patterson Creek	3268	Sec16,T22N,R34W–Sec11,T22N,R34W	2.0	1,2,3	P
South Indian Creek	3259	Sec24,T24N,R31W–Sec1,T23N,R30W	9.0	2,3,5	P

Beneficial Uses in Missouri: See 10 CSR 20-7.031(1)(C)
1. Irrigation
2. Livestock and Wildlife Watering
3. Protection of Warm Water Aquatic Life and Human Health (associated with) Fish Consumption
4. Cool Water Fishery
5. Whole Body Contact Recreation
6. Boating and Canoeing

Stream Classification System in Missouri

C Streams that may cease to flow in dry periods but maintain permanent pools which support aquatic life. See 10 CSR 20-7.031(1)(F)6.

P Streams maintain flow even during drought conditions. See 10 CSR 20-7.031(1)(F)4.

U Stream is unclassified—has no beneficial use designation.

Beneficial Uses for Ozark Highland Waters in Arkansas (includes headwaters for Little Sugar & Big Sugar Creeks):

1. Primary Contact Recreation
2. Secondary Contact Recreation
3. Domestic, Industrial and Agricultural Water Supply
4. Fisheries – Perennial Ozark Highlands Fishery

Identified Source on 303(d) List:
Livestock Production

TMDL Priority Ranking:
Medium for all stream segments

1.0 Background and Water Quality Problems

Many soils in southwest Missouri are not suited to row crop agriculture so farmers in that region have historically relied on raising livestock to provide income. In the early 1900's, a fruit and vegetable industry replaced the traditional grain and livestock production. After a series of droughts in the 1930's, the truck farming industry declined and was replaced by livestock production.[1] Since World War II, raising poultry has become an increasingly important source of income for residents in the watershed. But the enormous growth in the confinement production of poultry has occurred primarily during the past two decades. Typically, poultry farmers contract with large poultry production companies. The company, also referred to as the integrator, supplies birds, feed and a guaranteed market. The farmer supplies the buildings to grow the birds and disposes of the resulting litter, usually through land application on pasture or cropland. After a period of time, soils can become over-fertilized and runoff of nutrients becomes a problem. This has occurred in certain areas of the Elk River Basin.

An overabundance of nutrients, in particular nitrogen (N) and phosphorus (P), is a serious threat to aquatic ecosystems. The nutrients feed algal growth, also referred to as algal blooms, which will cause significant changes to the waterbody. This phenomenon is called eutrophication. Eutrophication is the natural aging of lakes or streams caused by nutrient enrichment (Sharpley et al, 1999). Cultural eutrophication is the accelerated aging of the natural condition caused by human activities.

Algal blooms at the surface of the water block light penetration and reduce nutrient availability to other algal species. This results in an overall reduction in the diversity of plant species. When algae die, they become a source of organic carbon that uses up the available dissolved oxygen in the water during decomposition. Decomposition also results in nutrients being released back into

[1] Missouri Department of Conservation web site, conservation.state.mo.us/fish/watershed/elk/landuse/0101utxt.htm

the water where they again stimulate algal growth, thus perpetuating the cycle. Algal blooms also impact recreational users and may produce taste and odor problems in drinking water systems.

The Elk River and its tributaries were included on the 1998 303(d) list with nutrients as the listed impairment. There are many potential sources of nutrient impairment. The major source originally identified on the 303(d) list was nonpoint source pollution from livestock production. In reality, the sources of the nutrient impairment include both point and nonpoint contributions. Rapid population growth is predicted to continue due to poultry production, Wal-Mart headquarters located in Bentonville, Arkansas, and retirees. Point and source concerns can be addressed through enforceable state issued permits, but the nonpoint source reductions must be achieved through voluntary efforts. Because of the diffuse nature of nonpoint source pollution, a variety of agricultural treatments or best management practices (BMPs) can help address the identified impairment. BMPs are methods that protect the environment and make economic sense for the farmer. Although BMPs are tailored to individual farms, when applied throughout the watershed, they collectively contribute to protecting water quality by decreasing erosion and surface water runoff.[2]

1.1 Physical Characteristics of Basin

The Elk River watershed is located in the southwest corner of Missouri, northwest corner of Arkansas, and northeast corner of Oklahoma. The Elk River is formed by the confluence of Big Sugar Creek and Little Sugar Creek at Pineville, Missouri, in McDonald County. Big Sugar originates in Benton County, Arkansas, and western Barry County in Missouri. The headwaters of Little Sugar Creek are also in Benton County, Arkansas. Another major tributary is Indian Creek, which is formed by the confluence of North, Middle and South Indian creeks. All segments of Indian Creek are within Missouri. Buffalo Creek and Patterson Creek confluence with the Elk across the state line in northeast Oklahoma.

Rainfall for the area averaged 44.6 inches for the years 1999-2001. Elevations range from 1500 feet at the plateau separating the Elk River Basin and White River Basin to approximately 800 feet at the Missouri-Oklahoma state line. Sheet and rill erosion on cropland is estimated at 13-18 tons/acre/year. Pasture erosion is estimated at 5-9 tons/acre/year. Forestland has an erosion estimate of 0.5 tons/acre/year. Erosion in the region is not considered to be a serious problem. Crop and pastureland comprises approximately 50 percent and forestland totals about 50 percent of the land uses in the Elk River basin.[3] A land use map and table containing detailed information on land use distribution in the Elk River Basin is available in Appendix B, Figure B-1 and Table B-1.

---

[2] http://www.nasda.org/nasda/nasda/Foundation/protect/summary.html

[3] Missouri Department of Conservation website, Elk River Basin, www.conservation.state.mo.us/fish/watershed/elk/contents/htm

1.2 Geological Characteristics of Basin

The Elk River basin is categorized as in the Ozark Plateau physiographic region and further as part of the Springfield Plateau region. The prevailing bedrock is Mississippian and is composed of limestones, shales and sandstones. Chert, also known as flint or jasper, is abundant. The region has areas of karst topography, which is characterized by soluble bedrock, which creates caves, losing streams, sinkholes and springs. There are more than 500 explored caves in McDonald County alone.[4]

The Huntington-Secesh soil association is located along the drainageways in the headwaters of the North, Middle and South Indian creeks and Buffalo Creek. It is characterized by nearly level to gently sloping, well drained, silty soils on flood plains and low terraces. This association is used for cropland and pastures, although flooding can be a problem for producers. The Nixa-Tonti and Nixa-Clarksville associations are predominant on the uplands. These are gently sloping to steeply sloping cherty and silty soils. Nixa-Tonti soils are used for pasture or grain production. Nixa-Clarksville soils are predominantly in timber, but can also be used for pastures. Steep slopes, abundant chert pieces, and lack of moisture-holding capacity limit farming use. All these soils have a fragipan, or hardpan layer of soil, that limits plant root growth. In the headwaters of Indian and Buffalo creeks, the Gerald-Creldon association predominates. It is characterized by nearly level to very gently sloping silty soils found on broad ridges of primary divides between watersheds. Much of this association is used for crops such as grain sorghum, small grains, soybeans and for cool-season pasture. It also has a fragipan layer.

In the Big Sugar headwaters, the Clarksville-Noark-Nixa soil association is found. It is characterized by very deep soils with gentle to very steep slopes. It is well drained to somewhat excessively drained. These very gravelly, silty soils are found in the upland areas of the Big Sugar basin.

Soils in the Little Sugar headwaters are in the Secesh-Britwater-Captina association. These are well drained to moderately well drained deep loamy soils with level to moderate slopes on flood plains and terraces. Uplands are of the Clarksville-Nixa-Noark association, which are excessively to moderately well drained, gently sloping to steep cherty soils on hills and ridges.

Because a Natural Resources Conservation Service soil survey does not currently exist for McDonald County, soils information for the Elk River itself and lower portions of Big and Little Sugar creeks, Buffalo Creek and the Indian Creek watersheds is limited. Some information about the upper reaches of these watersheds can be gleaned from soil surveys done in surrounding counties. Most of the Patterson Creek watershed is located within McDonald County, so no soils information is available at this time for this sub-watershed. The Natural Resources Conservation Service plans to release the McDonald Soil Survey sometime between 2003-2005.

---

[4] http://heartofhome.net/waterways/elk-river.htm

1.3 Hydrologic Characteristics in the Elk River Basin

The Elk River watershed encompasses 1,036 square miles and has 1,758 miles of classified streams identified in Missouri's Water Quality Standards. The highest average stream flows occur in April and May. The lowest flows occur in September, reflecting the rainfall patterns that commonly occur in Missouri.

Karst features are present in the watershed. Losing streams, which allow water to flow directly into the groundwater system, are common. In the Ozarks, many streams that lack year-round flows have losing stream segments. Buffalo Creek, Middle and South Indian Creek and Big Sugar Creek all have losing segments.

During the summer dry period, springs and groundwater recharge sustain stream flows. Springs are a natural resurgence of groundwater, usually on a hillside or the valley floor. Numerous springs are located in the Elk River basin. Julian Steyermarck, author of "Flora of Missouri," noted there was a decrease in the variety of plant life around the springs on the Springfield Plateau. It was speculated that the difference was the poor soils resulting from the weathering of limestone, as opposed to the dolomite soils found in other areas.[5]

1.4 Springs Located in the Basin

A large number of unnamed springs with varying small flows are located within the basin and are not identified here. Named springs and one unnamed spring of significant output are in the table below.

Table 2. Springs in the Missouri Portion of the Elk River Basin

Spring	Location	Flow
Unnamed Spring	Buffalo Creek	10-100 gpm
Whispering Spring	Buffalo Creek	NA
Many Springs	Bullskin Creek of Indian Creek	NA
Camp Beaver Spring	Indian Creek	1-10 ft^3/sec
Shannon Spring	North Indian Creek	NA
Weatherspoon Spring	Weatherspoon Creek of North Indian Creek	NA
Christian Spring	Middle Indian Creek	NA
He Hanken Spring	Middle Indian Creek	NA
Lentz Spring	South Indian Creek	NA
Macedonia Spring	South Indian Creek	NA
Deer Lick Spring	Mill Creek of Elk River	NA
Mullen Spring	North Fork of Patterson Creek	NA
Whittaker Spring	Big Sugar Creek	NA
Boarder Spring	Little Sugar Creek	NA

gpm = gallons per minute NA = Not available
ft^3/sec = Cubic feet per second (1 ft^3/sec = 448.83 gpm)

[5] Springs of Missouri, Jerry D. Vineyard and Gerald L. Feder, Missouri Department of Natural Resources, 1982.

1.5 Point Sources Located in the Basin

Sewage and agricultural processing effluents contain nitrogen and phosphorus that contribute to the nutrient loading in the receiving water. The following two tables contain the state operating permits in the basin that have been issued under the authority of the National Pollution Discharge Elimination System (NPDES). Appendix A, Table 4-A summarizes the Letters of Approval issued by the State of Missouri indicating an approved animal waste handling system is in place. These are not considered point source permits and, therefore, are not included in the information below.

Table 3: Missouri General and Storm Water Permits in the Elk River Watershed

Permit Number	Facility Name	Type1*	Type3*
MOG490088	Bailey Quarries-Jane	NO T	LIM Q
MOG490217	Camp Crowder Train Site	STO R	LIM Q
MOG490250	McClinton-Anchor	NO T	LIM Q
MOG490279	McDonald County Redi-Mix	NO T	LIM Q
MOG490319	Inland Rivers Aggregate C	NO T	LIM Q
MOG490347	Anchor Stone Neosho Quarry	NO T	LIM Q
MOG490392	Southwest City Redi-Mix	NO T	LIM Q
MOG490570	APAC, Central MO Div-Lanagan	NO T	LIM Q
MOG490711	Hutchens Const, Portec Plt	STO R	CONCR
MOG490714	N & M Concrete	STO R	CONCR
MOG490725	Neosho Concrete Products	STO R	CONCR
MOG500025	Ginas Gems Inc	SET B	SANDW
MOG500049	B & B Sand and Gravel Inc	STO R	GRAVW
MOG500093	3 D Sand & Gravel LLC	STO R	SANDW
MOR203133	Sunbeam Products, Inc	STO R	METAL
MOR203148	Eagle-Pitcher-Stella Prec	STO R	METAL
MOR210016	Neosho Concrete Products	STO R	CONCR
MOR23A063	Praxair Inc - Neosho Plant	STO R	CHEM
MOR409047	Jug Store Liquors	STO R	SOIL

Table 4: Missouri State NPDES Operating Permits in the Elk River Watershed

Permit Number	Facility Name	Type1*	Type3*
MO0002500	Tyson Food Inc	ACT S	P PRO
MO0025801	Anderson WWTF	UV DI	POTW
MO0041041	Wheaton WWTF	1C LA	POTW
MO0049948	Lanagan Housing Auth #1	EXAIR	SUBD
MO0054721	Noel WWTF	OXI D	POTW
MO0096679	Pineville WWTF	CON S	POTW
MO0100251	Lanagan Housing Auth #2	EXAIR	SUBD
MO0106135	Ginger Blue Resort	EXAIR	MOTEL
MO0108952	Simmons Hatchery	STO R	HATCP
MO0111023	Seligman WWTF	1 LAG	POTW

MO0112101	Talbot Ind, Inc – Plant #2	NO T	INDUS
MO0112534	Goodman WWTP	OXI D	POTW
MO0112631	Fairview WWTF	2CLAG	POTW
MO0123986	Quail Meadows MHP	SEP T	MHP
MO0124281	Stella WWTF	2CLAG	POTW
MO0125440	Gild Corp Shopping Center	ACT S	SHOP

*** Meaning of Acronyms Used in Permits Table 3 & Table 4**			
Type 1 Treatment Acronyms		Type 3 Facility Acronyms	
1C LA	One-cell lagoon	CHEM	Chemical Manufacturing
2C LA	Two-cell lagoon	CONCR	Concrete Products
ACT S	Activated Sludge	GRAVW	Gravel Washing
CON S	Contact Stabilization	HATCP	Private Poultry Hatchery
EXAIR	Extended Aeration	INDUS	General Industry
NO T	No Treatment	LIM Q	Limestone Quarry
OXI D	Oxidation Ditch	METAL	Metal Products
SEP T	Septic Tank	MHP	Mobile Home Park
SET B	Settling Basin	MOTEL	Motel
STO R	Stormwater Runoff	P PRO	Poultry Processing
UV DI	Ultraviolet Disinfection	POTW	City Wastewater Plant
		SANDW	Sand Washing
		SHOP	Store/Shopping Center
		SUBD	Public Subdivision

Table 5: Missouri CAFO Operating Permits in Elk River Basin
(See Figure A-1, Appendix A for Map)

Class IA = 7,000 or more animal units or 700,000 Broiler Chickens
Class IB = 3000 to 6,999 animal units or 300,000 to 699,999 Broiler Chickens
Class IC = 1,000 to 2,999 animal units or 100,000 to 299,999 Broiler Chickens
Class II = 300 to 999 animal units or 30,000 to 99,000 Broiler Chickens

Permit Number	Type	Class
MOG010032	Poultry	IC
MOG010143	Poultry	IC
MOG010189	Poultry	IC
MOG010287	Hogs	IC
MOG010288	Hogs	IC
MOG010291	Hogs	IB
MOG010293	Poultry	IC
MOG010294	Poultry	IC
MOG010296	Poultry	IC
MOG010297	Poultry	IC
MOG010298	Poultry	IC
MOG010299	Poultry	IC
MOG010306	Poultry	IC

MOG010308	Poultry	IC
MOG010309	Poultry	IC
MOG010313	Poultry	IC
MOG010314	Poultry	IC
MOG010317	Poultry	IC
MOG010319	Poultry	IC
MOG010321	Layer	IC
MOG010323	Turkey	II
MOG010327	Poultry	IC
MOG010332	Poultry	IC
MOG010343	Poultry	IC
MOG010351	Layer	IC
MOG010353	Poultry	IC
MOG010354	Poultry	IC
MOG010357	Poultry	IC
MOG010417	Poultry	IC
MOG010421	Poultry	IC
MOG010434	Poultry	IC
MOG010439	Bird	IC
MOG010442	Poultry	IC
MOG010445	Poultry	IC
MOG010448	Poultry	IC
MOG010449	Poultry	IC
MOG010458	Poultry	IC
MOG010467	Bird	IC
MOG010514	Poultry	IC
MOG010533	Poultry	IC
MOG010546	Poultry	IC

Table 6: Arkansas State NPDES Operating Permits in Elk River Watershed.

Permit Number	Facility Name
AR0022403	Bentonville, City of
AR0034258	Village Wastewater Co. (Bella Vista)
AR0020672	Pea Ridge, City of
AR0036480	Sulphur Springs, City of

1.6 Public Land in the Basin

There are multiple public areas in the Elk River basin, reflecting the importance of outdoor, water-based recreation in southwest Missouri and northwest Arkansas. There are eleven properties owned by the Missouri Department of Conservation including boat accesses, tower sites, natural areas and conservation areas. There is one National Military Park owned by the National Park Service. Four Missouri City Parks are located in the basin and one Missouri State Park. Arkansas has five City Parks within the basin.

1.7 History of Basin

The Elk River was a center for prehistoric peoples and culture. Several Early Mississippian Period (1100-800 BC) villages have been discovered in the Elk River basin. Constructed mounds for civil ceremonies, agriculture and far-flung trading characterized this civilization. Burial mounds and historical artifacts, such as Cahokia stone points, stone blades and knives, have been found in addition to pottery, sandstone pipes and hoes for cultivation of corn.

McDonald, Newton and Barry counties were all named for heroes from the Revolutionary War. McDonald County was named for Sergeant Alexander McDonald, a South Carolina soldier. Newton County was named for Sergeant John Newton who fought with Francis Marion, the Swamp Fox. There are two opinions regarding for whom Barry County was named. One is that it was named for Commodore John Barry, the "Father of the American Navy." The Missouri Secretary of State's office has information stating the county was named for U.S. Postmaster General William T. Barry.[6]

The Elk River basin was part of the "Six Boils" region in southwest Missouri. "Six Boils," also called "Six Bulls" due to regional accents, refers to the six major springs that feed the creeks and rivers in the area. Settlers named Big Sugar Creek and Little Sugar Creek for the many sugar maples found along the rivers. Numerous mills were established on the steams in the area, but during the Civil War the region was largely uninhabited except for marauding bands who loosely affiliated themselves with both the Union and the Confederacy. Population was also limited by the presence of large numbers of Confederate Troops that were camped on Cowskin Prairie. Their main purpose was to burn and pillage property and most mills were destroyed during that time. Numerous skirmishes and battles occurred in the area. Pea Ridge, the Civil War battle that retained Missouri in the Union, followed the Battle of Wilson's Creek and was fought across the border near Bentonville, Arkansas. The river port of St. Louis was vital to controlling the west, and Springfield was the key to keeping St. Louis in Union hands. Confederates from Fayetteville, Arkansas, kept attacking the town, so a campaign was mounted to stop Confederate incursions into Missouri. On March 7 and 8, 1862, the 16,000 man Confederate troops met the 10,500 Union troops on the banks of the Little Sugar Creek in Arkansas to decide who would control the West. In the first attack, two Confederate generals were killed and a ranking colonel was captured. Union troops controlled key positions, and the Confederates were defeated after two days of fighting. The Confederate army was ordered east and the Confederates effectively abandoned Arkansas and Missouri for the duration of the war.

Agriculture in post-Civil War southwest Missouri flourished. Because of the mild climate and fertile bottomland soils, the area produced crops of grapes, fruits, vegetables and grain. Livestock ranged freely throughout the year and required little tending. Steam saws and gristmills were built on streams to take advantage of waterpower. Unimproved land could be bought for \$3-\$10 per acre, and improved land brought \$5 to \$25 per acre. Prior to the Civil War, cattle numbered 2,525, hogs totaled 4,208 and sheep numbered 1,912. By 1880, livestock numbers had grown to 6,293 cattle, 24,636 hogs and 4,525 sheep. The region saw continued growth in population, especially after World War II. From 1990 to 2000, population in the three Missouri counties has grown an average of 23.3 percent.

[6] http://www.sos.mo.gov/archives/history/counties.asp

In 1938, a movie was filmed at Pineville in McDonald County and it is considered the first modern Western. "Jesse James" was filmed in Technicolor and on location. This movie became a major box-office success. Tyrone Power, Henry Fonda and Randolph Scott starred in this picture originally envisioned to be a factual history of the life of Jesse James.[7] Jo Frances James, great-granddaughter of Jesse James, was hired to ensure historical accuracy, but she was disappointed with the result. She said, "I don't know what happened to the history part of it. It seemed to me (that) the story was fiction from beginning to end. About the only connection it had with fact was that there once was a man named James and he did ride a horse." Pineville was transformed into an 1800's town by adding false fronts over existing stores and spreading dirt on the paved roads.

2.0 Description of the Applicable Water Quality Standards

The following is information regarding which sections of the State of Missouri's Water Quality Standards apply to this TMDL. Chapter 7 of the standards, which contains these sections, may be found on the department's web site at:

http://www.sos.mo.gov/adrules/csr/current/10csr/10c20-7a.pdf

2.1 Specific Criteria

The impairment of the listed segments in the Elk River basin is based on exceedence of the general criteria contained in Missouri's Water Quality Standards, 10 CSR 20-7.031(3)(A) and 10 CSR 20-7.031(3)(C). The general criteria state:

- Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.
- Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses.

The Elk River is on the 1998 303(d) list for excess nutrient loading. Nutrient related water quality standards issues include:

- Proliferation of nuisance algae and the resulting unsightly and harmful bottom deposits
- Turbidity due to suspended algae and the resulting green color
- Low dissolved oxygen caused by extreme swings in oxygen production by over abundant plant life and oxygen depletion resulting from the decomposition of algae and other plants can have a negative impact on aquatic organisms
- Organic enrichment when algal blooms die off, which perpetuates the cycle of excessive plant growth

2.2 Anti-degradation Policy

Missouri's Water Quality Standards include the Environmental Protection Agency (EPA) "three-tiered" approach to anti-degradation and may be found at 10 CSR 20-7.031(2).

[7] http://library.cmsu.edu/vertrece/jesse.htm

Tier I defines baseline conditions for all waters and requires that existing beneficial uses are protected. TMDLs would normally be based on this tier, assuring that numeric criteria (such as dissolved oxygen and ammonia) are met to protect uses.

Tier II requires that no degradation of high-quality waters occur unless limited lowering of quality is shown to be necessary for "economic and social development." A clear implementation policy for this tier has not been developed, although if sufficient data on high-quality waters are available, TMDLs could be based on maintaining existing conditions rather than the minimal Tier I criteria.

Tier III (the most stringent tier) applies to waters designated in the water quality standards as outstanding state and national resource waters; Tier III requires that no degradation under any conditions occurs. Management may prohibit discharge or certain polluting activities. TMDLs would need to assure no measurable increase in pollutant loading.

This TMDL will result in the protection of existing beneficial uses, which conforms to Missouri's Tier I anti-degradation policy.

3.0 Calculation of the Load Capacity

Calculating the load capacity and numeric nutrient targets requires a linkage between the narrative criteria (unsightly or harmful bottom deposits) and a numeric target that can be measured (pounds of total phosphorus). The numeric target should apply to the pollutant of concern and if reductions are achieved, it will have a direct impact on remediation of the impairment.

The term "limiting factor" in this document refers to the nutrient that limits plant growth when it is not available in sufficient quantities. Generally, a system is either nitrogen- or phosphorus-limited. The ratio of nitrogen to phosphorus in the average plant biomass is about 7.2 to 1 (Chapra, 1997). Chapra's ratio determination is based on the stoichiometric composition of organic matter assuming that plant protoplasm is one percent phosphorus on a dry basis. An N:P ratio of less than 7.2 would suggest a nitrogen-limited environment. Alternatively, a ratio greater than 7.2 would indicate that phosphorus is the limiting element. In the Elk River the N:P ratio is 17, thereby indicating a phosphorus-limited ecosystem.

Flow and water quality data collected from the Elk River at Tiff City were used for trend analysis to determine if nutrient accumulation was occurring over time. It should be noted the period of record for flow data at Tiff City 1940 - 2002. The period of record for water quality data at this same site is 1966-2002. The trend analysis, coupled with repeated complaints from the general public regarding nuisance algae, was the basis for the 303(d) listing.

3.1 Total Phosphorus (TP) Target

Statistical analysis of total phosphorus concentrations during the periods of 1966-1984 and 1985-2002 showed a significant difference (see Table 6 below). The data suggest that 1985 was the beginning of accelerated phosphorus loading that led to the 1998 listing of eleven stream segments within the watershed. The total phosphorus target for this TMDL is based on historical water quality data collected before 1985.

Table 7: Comparison of TP Concentrations between Existing and Reference Data[8]

t-Test: Two-Sample Assuming Unequal Variances	1966-84	1985-2002
Mean	0.063819444	0.093892617
Variance	0.007819576	0.007402313
Observations	144	149
Hypothesized Mean Difference	0	
df	290	
t Stat	-2.949164529	
P(T<=t) one-tail	0.001722902	
t Critical one-tail	1.650123522	
P(T<=t) two-tail	0.003445804	
t Critical two-tail	1.968178367	

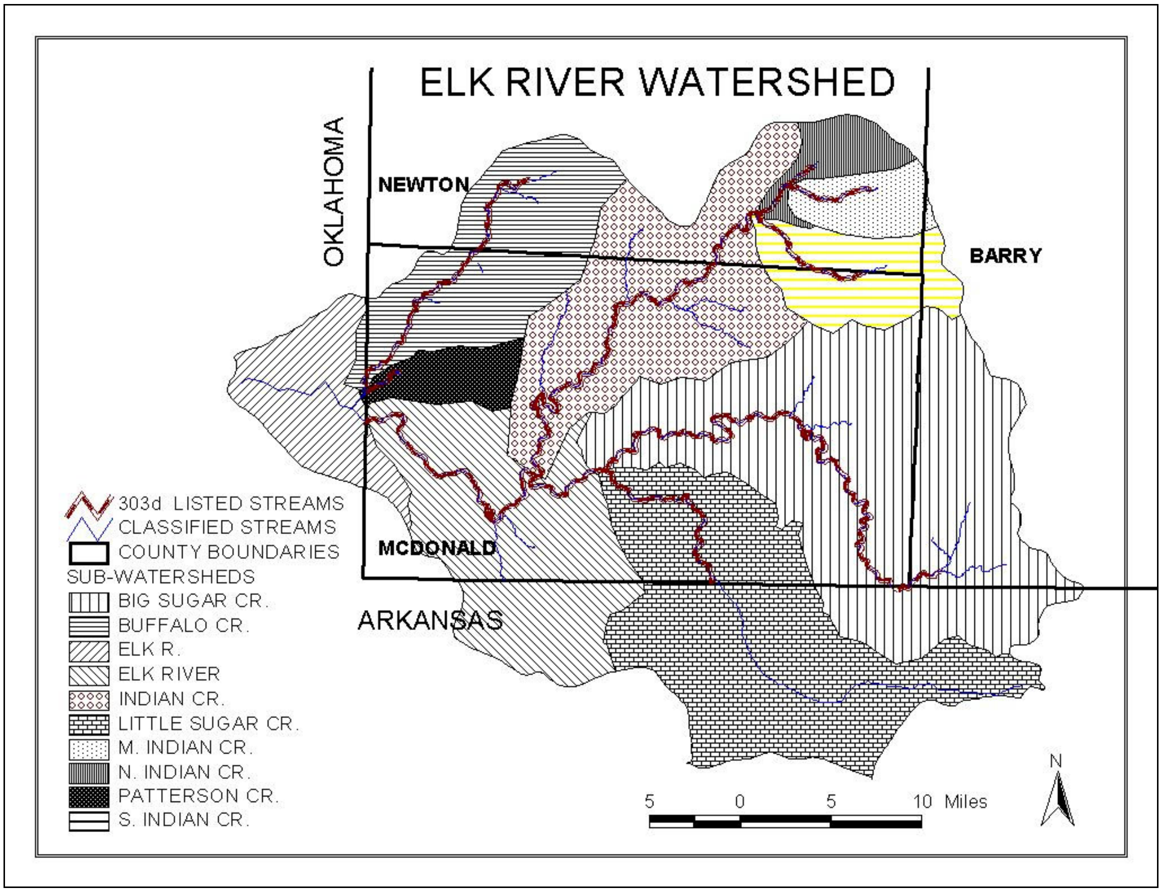
The water quality monitoring station on the Elk River at Tiff City (USGS0789000) has been in operation since 1966. The United States Geological Survey (USGS), Oklahoma District maintains the station. There are a total of 283 records of water quality data that were collected between 1966 and 2002. The reference data set, consisting of information collected between 1966-1984, contains 136 records. The average total phosphorus concentration of the reference data is 0.0638 mg/L (rounded to 0.06 mg/L or 60 μg/L). This phosphorus concentration represents the conditions that existed before eutrophication of the river was an issue. The value 0.06 mg/L is, therefore, the Phase I target for the Elk River TMDL. Progress toward this target will be evaluated by analyzing ambient water from the Elk River at the Tiff City gage station.

Buffalo and Patterson creeks are part of the Elk River basin, but their confluence with the mainstem is in Oklahoma. They are not part of the Elk River watershed that is evaluated by the data collected at Tiff City (Figure 1). These two watersheds do not have extended historic data records. Because of this data limitation, the assumption was made that there is homogeneity within the Elk River watershed. The Phase I target of 0.06 mg/L will also apply at the outlets of these two sub-watersheds. Consequently, a uniform percent reduction in nutrients will apply to the entire Elk River Watershed.

---

[8] A Kruskall-Wallace test and a 2-sample T test on log transformed data also show a statistically significant difference ($p < 0.05$).

Figure 1: Elk River Watershed Addressed by the TMDL



The Elk River Basin has experienced a marked increase in poultry production that accounts for a large measure of the surge in nutrient loading to the Elk River over the past two decades. According to data obtained from the National Agricultural Statistical Service (NASS), U.S. Department of Agriculture, the yearly average number of poultry increased by 104 percent since 1985 when compared to data collected prior to 1985. During this same time frame, hog and cattle numbers have declined slightly (Tables A-1 through A-3, Appendix A). As agricultural statistics are reported only on a countywide basis, it was necessary to assume that animal density was uniform within each county to derive these comparisons. Another indicator of the major contribution of nutrients due to poultry production is evident in Table A-4, Appendix A. This table summarizes the Letters of Approval issued by the State of Missouri for animal waste management systems. These numbers indicate that there are approximately 530,000,000 Poultry Broilers in the Missouri portion of the Elk River watershed. Obtaining a Letter of Approval from the state is optional for the producer. Hence, the numbers represented in Table A-4 may be an underestimate of the actual number of birds in the watershed. Figure A-1, Appendix A is a map of the permitted CAFO's in the Missouri portion of the Elk River Watershed and again is an indication of the density of poultry production that exists in some areas of the watershed.

The Elk River watershed addressed by this TMDL spans four counties, one in Arkansas and three in Missouri (see Figure 1). Only a quarter of Benton County in Arkansas is in the Elk River watershed. The sub-watersheds of Big Sugar and Little Sugar creeks originate in Arkansas.

3.2 Total Nitrogen (TN) Target

The total nitrogen target is based on the ratio of total nitrogen to total phosphorus that was derived from the reference data. The calculated yearly average N:P ratio derived from reference data is 17. Use of this ratio produces a concentration-based result of 1.0 mg/L total nitrogen. This is expressed by the following equation:

N:P ratio x TP target = TN target
17 x 0.06 = 1.0 mg/L

3.3 Modeling Approach

A load duration curve was developed to model the Elk River TMDL. The curve is a graphical representation of the percent of time when the value of a given parameter is exceeded. In this case, it is the probability at which the total phosphorus or total nitrogen load will be exceeded. This method offers a number of advantages including:

- Ease of visualization and interpretation
- Considers all flow regimes instead of a single point estimate
- Reflects the relative contribution of all sources within any given flow range
- Matches the appropriate implementation efforts with the source of loading

3.4 TMDL Calculation

A TMDL is a calculation used to establish an acceptable pollutant load for an impaired waterbody and to allocate the load between contributing sources. This includes point, nonpoint and natural background sources that exist in the watershed. It provides the foundation for establishing an implementation plan to restore and maintain a waterbody's designated beneficial uses.

The resultant graph or curve is the product of the target concentration in mg/L, the flow in cubic feet per second and a conversion factor. The result is in pounds of total phosphorus per day. The lowest load corresponds to the lowest flow and highest probability and does not include loading from stormwater runoff. In this low flow range, the load allocation for nonpoint source contributions is zero. As the flow increases, the nutrient loading increases and the load allocation for nonpoint source gets larger while the wasteload allocation for point sources remains constant through all flow regimes. This is due to the constant load coming from point sources that have relatively constant discharges. The TMDL is therefore a continuum of nutrient loading over the entire range of flows.

The following figures are the load duration curves for total phosphorus and total nitrogen in the Elk River. They are graphic representations of the TMDL across the range of possible flows. Both graphs include data points from pre-1985 and post-1985 and show the historical and current exceedences of the load capacity being established by this TMDL.

Figure 2: TP Load Duration Curve - Reference and Existing Load at Tiff City

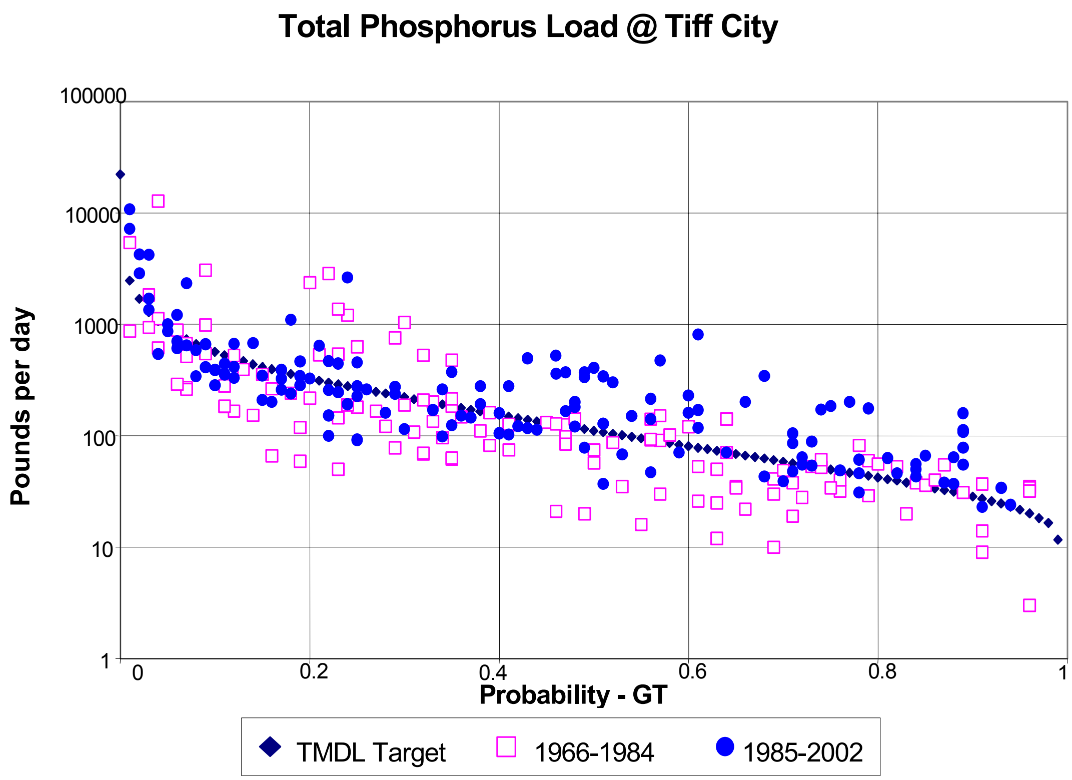
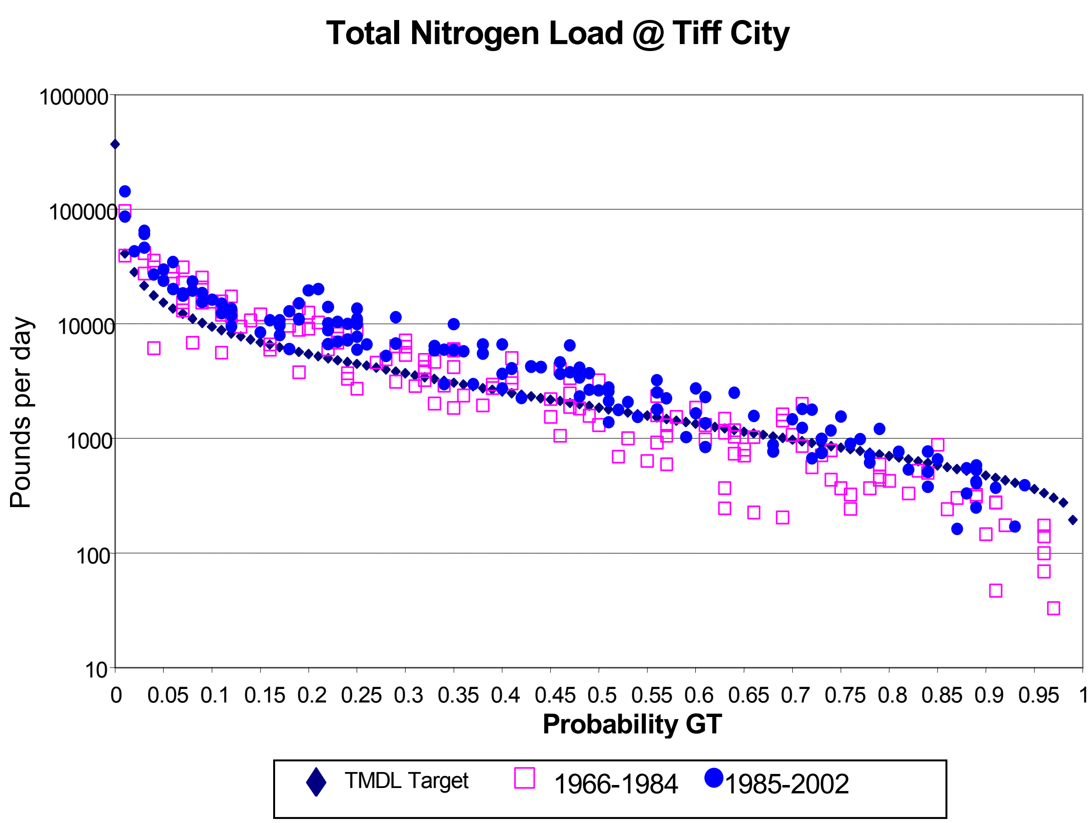


Figure 3: TN Load Duration Curve - Reference and Existing Loads at Tiff City



All TMDLs can be expressed in terms of the following equation:

TMDL or LC = WLA + LA + MOS

Where:

LC = Loading Capacity or the amount of pollutant load a waterbody can assimilate without violating state water quality standards.

WLA = Waste Load Allocation or the portion of the Load Capacity allocated to existing or future point sources.

LA = Load Allocation or the portion of the Load Capacity allocated to existing or future nonpoint sources and natural background.

MOS = Margin of Safety or an accounting for the uncertainties and variables that impact the relationship between pollutant loads and receiving water quality. The Margin of Safety can be provided implicitly through analytical assumptions, or explicitly by reserving a portion of Load Capacity.

The following sections explain the methods used for determining the WLA, LA and MOS.

4.0 Waste Load Allocation (WLA)

The Waste Load Allocation is the portion of the Load Capacity allocated to existing and/or future point sources.

4.1 Total Phosphorus WLA

The total phosphorus load for the period 1985-2002 is relatively higher at the 0.4 to 1.0 probability range than at probabilities less than 0.4 (Figure 2). This observation suggests that currently concentrations are higher during low flow conditions. Conversely, the 1966-1984 historic data showed higher TP loads at high flows than at medium and low flows. These two observations imply that since 1985, the total phosphorus loading shifted toward point sources. These point sources include municipal wastewater treatment plants and poultry processing plants. The volume of both types of discharges has increased with the growth of the poultry industry. Increases in wastewater discharges are directly related to the growth of population, which is indirectly related to the availability of jobs in the animal production industry.

The system's capacity to assimilate the waste load contribution from point sources was determined using an analysis of the base-flow of the Elk River at the USGS gage at Tiff City. Using the USGS Hydrologic Separation Program (HYSEP), the median base-flow of all events for the period of record, Water Year 1940 to Water Year 2002, was calculated. The local minimum method was used to determine a base-flow of 250 ft^3/s (Table A-5, Appendix A). This base-flow corresponds to a 60 percent probability on the flow duration curve. At that probability, the target point source load is 81 pounds per day. This can be expressed by the following equation. The conversion factor of 5.395 converts a concentration (mg/L) to a load (pounds per day).

Calculated Base-Flow x Target Concentration x Conversion Factor = Load Capacity in lb/day
250 ft^3/s x 0.06 mg/L x 5.395 = 81 lb/day

There are 36 active Missouri state permits in the Elk River watershed, but only 34 drain into Elk River at Tiff City. These include 15 operating permits, 14 general permits, and 5 stormwater permits (Tables 3 & 4 above). The existing combined design flow of the operating permits in Missouri is about 5.1 ft^3/s. The existing point source load as measured at the end-of-pipe and reported in the Discharge Monitoring Reports amounts to 362 pounds of total phosphorus per day (Table 8). Only six operating permits have total phosphorus monitoring and reporting requirements. For the purpose of this calculation, it is estimated that wastewater treatment facilities discharge the same TP concentration. Therefore, an average concentration of 5.0 mg/L, as reported by some facilities, was applied to the permits that are not required to monitor for TP. All the general and storm water permits contribution to nutrient loading is contingent on runoff events. Thus, the WLA for the general and storm water permits is set at zero for base-flow conditions. During periods of runoff, the WLA will depend on best management practices (BMPs) included in the permit.

In Arkansas, there are four state operating permits that discharge to the Elk River watershed (Table 8). The average daily total phosphorus loading from these point sources is 268 pounds per day at a design flow of 7.44 ft^3/s. Adding this amount to the daily load from point sources in Missouri, the result equals 630 lb/day at an existing design flow of 12.5 ft^3/s.

Table 8: Point Sources Contribution to TP Loading in the Elk River at the Tiff City Gage

Permit Number	Facility Name	Design Flow (ft^3/s)	Design Flow (gallons/day)	TP (mg/L)	Existing Load (lb/day)
Missouri					
MO0002500	Tyson Food Inc	2.325	1,500,000	20	250.868
MO0025801	Anderson WWTF	0.961	620,000	11	57.031
MO0112101	Talbot Ind, Inc	0.623	402,000	5	16.808
MO0054721	Noel WWTF	0.310	200,000	5	8.362
MO0111023	Seligman WWTF	0.233	150,000	5	6.272
MO0096679	Pineville WWTF	0.192	124,000	7	7.258
MO0041041	Wheaton WWTF	0.161	104,000	5	4.348
MO0108952	Simmons Hatchery	0.140	90,000	11	8.279
MO0124281	Stella WWTF	0.053	34,000	5	1.422
MO0112631	Fairview WWTF	0.045	29,000	5	1.213
MO0106135	Ginger Blue Resort	0.008	5,000	5	0.209
MO0123986	Quail Meadows MHP	0.06	4,000	5	0.167
MO0049948	Lanagan Housing Auth #1	0.003	2,000	5	0.084
MO0100251	Lanagan Housing Auth #2	0.003	2,000	5	0.084
MO0125440	Gild Corp Shopping Center	0.002	1,000	5	0.042
	Subtotal	5.064	3,267,000		362.445
Arkansas					
AR0022403	Bentonville, City of	6.200	4,000,000	7	234.143
AR0034258	Village Wastewater Co. (Bella Vista)	0.620	400,000	5	16.725
AR0020672	Pea Ridge, City of	0.465	300,000	5	12.543
AR0036480	Sulphur Springs	0.155	100,000	5	4.181
	Subtotal	7.440	4,800,000		267.592
	TOTAL	12.504	8,067,000		630.037

Other stream and watershed processes, such as deposition, re-entrainment, additional loading and dilution impact the point source loads calculated above. Using the assumption of constant loading from point sources does not account for treatment facilities that may have infiltration problems with older collection systems. Infiltration could impact the loading from point sources during high flows as excess quantities of water passing through the plant may result in discharges that by-pass the treatment process. The department is aware of infiltration issues at facilities and works with permitted entities to prevent by-passes. Despite the variables listed above, use of the constant load assumption for point sources allowed allocations to be derived from the available data. The wasteload and load allocations will be adjusted if future data indicates the current allocations are inaccurate.

Under base-flow conditions at Tiff City, the observed load of 228 lb/day will be used as a reference condition that is believed to reflect the instream and watershed effects. The point source load was combined with the background load to produce the observed load of 228 lb/day. This observed load represents the 95th percentile of all measured loads that occurred within the base-flow range from 0 to 250 ft^3/s (Figures A-2 and A-3, Appendix A). This 95th percentile was selected to compare with the upper bounds of the target value within the same flow range. To meet the TMDL target load within the 0 to 250 ft^3/s flow range, the existing load should be reduced by 64 percent. The calculation can be expressed as:

([Observed Load – Target Load] / Observed Load) = percent Reduction
([228 – 81] / 228) = 64 percent

Table 9: Proposed Load Reduction of TP in the Elk River at Tiff City for Point and Nonpoint Sources

Flow Probability Range	Existing Load *	Estimated Existing Source Contribution		Target Load at Tiff City lb/day	Total Reduction		WLA Share of Reduction	LA Share of Reduction
		Point lb/day	Nonpoint lb/day		lb/day	TMDL		
60-100%	228	228	0	81	147	64%	100%	0%
40-59%	483	228	255	154	329	68%	45%	55%
20-39%	547	228	319	327	220	40%	67%	33%
4-19%	1,143	228	915	1,062	81	7%	100%	0%
1-4%	9,715	228	9,487	2,462	7,253	75%	2%	98%

*95th percentile of data within flow range

Two facilities in the watershed were having nutrient limits added to their permits prior to the development of this TMDL. The planned changes include a total phosphorus effluent limit of 1.0 mg/L monthly average concentration for the Bentonville Arkansas treatment facility and 1.5 mg/L daily maximum for the Tyson Noel Processing Plant in Missouri. Although the Tyson Noel permit has not yet been issued, the compliance schedule contained in a consent decree agreement between the company and the State of Missouri ensures the limits will go into affect in the near future. These two permit actions will result in reducing the current load of phosphorus from 630 lb/day to 225 lb/day. Assuming that the contribution from nonpoint sources is not a factor within the base-flow range, this reduction is equal to the target of 64 percent established for base-flow conditions as measured at the Tiff City gage (Table 8).

For Phase I of this TMDL, all permitted facilities in Missouri discharging to the Elk River or its tributaries and with a design flow greater than or equal to 400,000 gallons per day (0.4 MGD or 0.62 ft^3/s) shall have total phosphorus limits included in their permit. The limits will be no more than 1.5 mg/L TP as a maximum daily concentration nor more than 1.0 mg/L as a monthly average. These effluent limits shall apply to any new facility regardless of the size of the discharge. The same limit shall also apply to existing facilities if they expand beyond their current design flow and the proposed design flow is equal to or greater than 22,500 gallons/day. Table 10 below shows the existing and future TP loads for all facilities in the watershed draining into the Elk River at Tiff City. The resulting point source contribution reduction is 74%. This percent reduction is calculated by use of the following equation:

Current TP Load – TP Load After Implementation / Current TP Load = percent Reduction
(630 - 163) / 630 = 74.13 percent

A total phosphorus permit limit of 1.0 mg/L monthly average and a 1.5 mg/L daily maximum are essentially equivalent. Consequently, the permit limits being proposed by Arkansas and Missouri will result in equivalent permit limits throughout the basin. It should be noted that conditions related to size of facility required to have nutrient limits or the permit limits themselves might change in the future. Using the adaptive management approach, if monitoring indicates a need for further reductions in the point source load, the size of discharge required to have nutrient permit limits or the permit limit itself may change. Any changes that are considered will be based on quality assured data that is collected post-implementation.

Table 10 below includes specific information regarding the loading from point sources in Arkansas. These numbers, based on information provided by the Arkansas Department of Environmental Quality (ADEQ) as to their current plans for addressing point source discharges in the Elk River watershed, were the pollutant inputs upon which the TMDL was based. It is not the intent of the State of Missouri to dictate how the State of Arkansas addresses point and nonpoint sources of nutrients. Therefore, the State of Missouri is only establishing the allocations in Missouri and is not taking action with respect to any allocations, point or nonpoint, in Arkansas. As the TMDL is implemented and further data is obtained, on-going negotiations between the states will address any changes that are needed to ensure the nutrient impairment of the Elk River is corrected. The TMDL may also be modified as the Oklahoma Department of Environmental Quality addresses impairments in their portion of the watershed. Restoration of impaired waters is best accomplished by individual states tailoring their portion of the implementation plan to the laws, funding opportunities and knowledge of the resource that exists within each state agency.

Table 10: Point Source Contributions after Implementation of a 1.5-mg/L TP Limit

Permit Number	Facility Name	Design Flow (ft^3/s)	Design Flow (gallons/day)	TP (mg/L)	Existing Load (lb/day)	Waste Load Allocation (lb/day)
Missouri						
MO0002500	Tyson Food Inc	2.325	1,500,000	20	250.868	29.163
MO0025801	Anderson WWTF	0.961	620,000	11	57.031	7.777
MO0112101	Talbot Ind, Inc	0.623	402,000	5	16.808	5.042
MO0054721	Noel WWTF	0.310	200,000	5	8.362	8.362
MO0111023	Seligman WWTF	0.233	150,000	5	6.272	6.272
MO0096679	Pineville WWTF	0.192	124,000	7	7.258	7.258
MO0041041	Wheaton WWTF	0.161	104,000	5	4.348	4.348
MO0108952	Simmons Hatchery	0.140	90,000	11	8.279	8.279
MO0124281	Stella WWTF	0.053	34,000	5	1.422	1.422
MO0112631	Fairview WWTF	0.045	29,000	5	1.213	1.213
MO0106135	Ginger Blue Resort	0.008	5,000	5	0.209	0.209
MO0123986	Quail Meadows MHP	0.06	4,000	5	0.167	0.167
MO0049948	Lanagan Housing Auth #1	0.003	2,000	5	0.084	0.084
MO0100251	Lanagan Housing Auth #2	0.003	2,000	5	0.084	0.084
MO0125440	Gild Corp Shopping Center	0.002	1,000	5	0.042	0.042
	Subtotal	5.064	3,267,000		362.445	79.722
Arkansas						
AR0022403	Bentonville, City of	6.200	4,000,000	7	234.143	50.174
AR0034258	Village Wastewater Co. (Bella Vista)	0.620	400,000	5	16.725	16.725
AR0020672	Pea Ridge, City of	0.465	300,000	5	12.543	12.543
AR0036480	Sulphur Springs	0.155	100,000	5	4.181	4.181
	Subtotal	7.440	4,800,000		267.592	83.623
	TOTAL	**12.504**	**8,067,000**		**630.037**	**163.345**

* Tyson's existing load is calculated on the current design flow of 1,500,000 gallons/day (2.325 ft^3/s), whereas the WLA is based on the proposed design flow of 2,300,000 gallons/day (3.65 ft^3/s), as is proposed for the new permit.

** The 1.0 mg/L monthly average is reflected in this calculation as 1.5 mg/L maximum daily limit.

4.2 Total Nitrogen (TN) WLA

The same calculation approach used to determine TP point source contribution and reduction is also used for TN. The target reduction within the base-flow (0 – 250 ft^3/s) is 42 percent. Table 11 contains the percent reduction for nitrogen within each of the flow ranges selected. Using the 17:1 TN/TP ratio, the TN effluent limit for permitted facilities with a design flow greater than 400,000 gallons per day is 25.5 mg/L as a daily maximum. Total nitrogen is the sum of total Kjeldahl nitrogen (TKN) and nitrite plus nitrate nitrogen ($NO_2 + NO_3$ as N).

Table 11: Proposed Load Reduction of TN in the Elk River at Tiff City for Point and Nonpoint Sources

Flow Probability Range	Existing Load *	Estimated Existing Source Contribution Point lb/day	Estimated Existing Source Contribution Nonpoint lb/day	Target Load at Tiff City lb/day	Total Reduction lb/day	Total Reduction TMDL	WLA Share of Reduction	LA Share of Reduction
60-100%	2,317	2,317	0	1,343	974	42%	100%	0%
40-59%	5,533	2,317	3,216	2,668	2,865	52%	34%	66%
20-39%	16,829	2,317	14,512	5,459	11,370	68%	9%	91%
4-19%	28,822	2,317	26,505	17,696	11,126	39%	9%	91%
1-4%	129,254	2,317	126,937	41,029	88,225	68%	1%	99%

*95th percentile of data within flow range

5.0 Load Allocation for Total Phosphorus and Total Nitrogen

The Load Allocation is the amount of loading that may be contributed by nonpoint sources. The load allocation is associated with storm events that cause runoff of nutrients from the land. Phosphorus is often bound to soil particles and is deposited on stream bottoms with the sediment. High flow events can disturb the streambed and cause phosphorus to be re-suspended in the water column. This 'flushing' phenomenon would under estimate the WLA or point source contribution during base-flow conditions and over estimate the LA or nonpoint source contribution during high flow. The under estimation of the point source load can result from part of the load becoming entrained in sediments. The load attributed to nonpoint sources during high flows could be over estimated because it includes the part of the point source load that has been re-suspended. High velocity water, as occurs during rain events, tends to contain more dissolved oxygen than slow moving water, as occurs during periods of no rainfall. Hence, according to the phosphorus flux model (Ditoro, 2001), phosphorus suspension in the water column is more likely to occur under high flow, aerobic conditions than under low flow, anaerobic conditions. The total phosphorus and total nitrogen loads from nonpoint sources are represented on the load duration curves, Figures 2 and 3, and correspond to a flow probability ranging from 0 to approximately 59 percent. The percent reductions in TP and TN loading from nonpoint sources are specified in Tables 9 and 11 above.

The categories of nonpoint sources potentially making contributions to the nutrient load include:

- Failing On-Site Septic Systems
  On-site sewage treatment systems have the potential to deliver nutrient loads to surface water due to malfunction, failure, or direct pipe discharge. Properly operated and maintained, septic systems can effectively treat wastewater and prevent surface and ground water contamination. Citizens in the watershed have expressed concern regarding the effectiveness of older or poorly maintained on-site systems.

- Land application of commercial fertilizers, manure and poultry litter
  The amount of poultry litter produced by the poultry production industry in the Elk River watershed is problematic. The litter removed from the houses has usually been land applied on nearby pastures and fields and often on the property of the poultry producer. As soils in the watershed became saturated with phosphorus, high levels of TP were found in some

springs in the watershed. Springs help provide the base flow in the Elk River. A survey by the University of Missouri of rural wells in McDonald County was completed in 1992 (Sievers and Fulhage). The authors concluded that the level of nitrates in wells was elevated over the levels that had been reported in 1969. The study states that there was a significant correlation between wells with high levels of nitrates and fecal coliform and the geology of the area and where animals were raised or their wastes land applied.

- Grazing animals
  Grazing animals deposit manure on pastureland where it may run off during storm events and deliver nutrients to the water. Some cattle producers have already implemented best management practices, but in many cases, cattle have unlimited access to the river and its tributaries. This can result in direct nonpoint source inputs when cattle defecate directly into the river. Excessive numbers of cattle in one area can also cause erosion from fields and stream banks. As phosphorus is often bound to soil particles, this pasture erosion can also contribute to the nutrient loading in the river and its tributaries.

- Wildlife
  Waste matter from wildlife, such as deer, waterfowl and raccoons, can add to the nutrient loading of a waterbody. The assumption is that wildlife and the manure they produce is evenly distributed over forested and agricultural land.

- Urban development
  Urban areas include barren and built-up-land. Nutrient loading from densely populated areas occurs mainly during rain events through storm water runoff. Many of the communities within the Elk River watershed are small and widely spaced. The following is a list of the largest communities in the Elk River watershed with population figures obtained from the 1990 and 2000 census.

Table 12: Growth of Urban Population in Elk River Watershed during the Last Decade

Location	1990 Census Data	2000 Census Data
Bentonville, AR	11, 285	19,730
Bella Vista, AR	9,083	16,582
Pea Ridge, AR	1,640	2,346
Anderson, MO	1,432	1,856
Noel, MO	1,147	1,480
Goodman, MO	1,094	1,183
Seligman, MO	566	877
Pineville, MO	590	786
Wheaton, MO	632	721
Fairview, MO	304	395
Stella, MO	139	178
Total:	27,912	46,134

This demonstrates the potential for existing and future problems from urban runoff as the communities in this watershed continue to increase in population. The largest population growth is occurring in northwest Arkansas. It should be noted, however, that growth has also

occurred in the municipalities in Missouri. Both trends are predicted to continue by the Census Bureau and local residents. A major concern with population growth is the potential for a reduction in the amount of intact forestland that currently exists in the watershed. Forests and other heavily vegetated lands slow or prevent runoff during rain events. When forests are cleared for development purposes, the potential for runoff of harmful pollutants increases exponentially.

- Recreational Use

The Elk River is a typical Ozark Stream with a gravel bottom, permanent flow and good fishing. There are several thriving canoe liveries in the watershed. Recreational use by canoeists and fishermen can be a nonpoint source of nutrient inputs if users do not use toileting facilities. Although the Elk River does receive a high level of recreational use, this use has not proven to be a major water quality concern based on the existing data. Concerns related to recreational use, however, have frequently been expressed by local citizens. One concern is the litter deposited along the river and canoe liveries have been proactive in trying to address this issue. Another major concern is the lack of public toileting facilities near the river. This is a difficult issue to address, as provision of toileting facilities near the river also have a high risk of being damaged during flood events. In dealing with a similar concern on the Jacks Fork River, the National Park Service has found permanent buildings with flush toilets receive the most use from the public and are more likely to survive flood events. The cost for constructing such facilities is initially greater, but is more likely to provide the desired benefits. Approaching public landowners along the river, such as the National Forest Service, the Missouri Department of Conservation or municipalities, regarding the provision of toileting facilities is one option. Pursuit of grant money to help provide bathroom facilities is also an option. The Elk River Watershed Improvement Association may choose to address this issue based on the concerns of local residents.

6.0 TMDL Results Discussion

The current total phosphorus and total nitrogen loads in the Elk River as measured at Tiff City are above the calculated assimilative capacity of the waterbody. The required load reduction for each flow regime is based on equating the upper limit of the TMDL load and the 95th percentile of the existing load in any flow range (Tables 8 & 10). About 60 percent of the time, the nutrient impairment in the Elk River is due to point sources. Figures 4 and 5 below are graphic representations of the Load Duration Curve with a plot of the “new load” that would result after implementation of this TMDL. The data points were extrapolated from existing data and show what would likely occur after implementation of TP limits and BMPs. Within the probability range of 0.6 to 1.0 (corresponding to a flow range 0 to 250 ft^3/s), the new load is entirely comprised of the wasteload allocation and point source reductions in loading.

Figure 4: Total Phosphorus Reduction at Different Flow Ranges

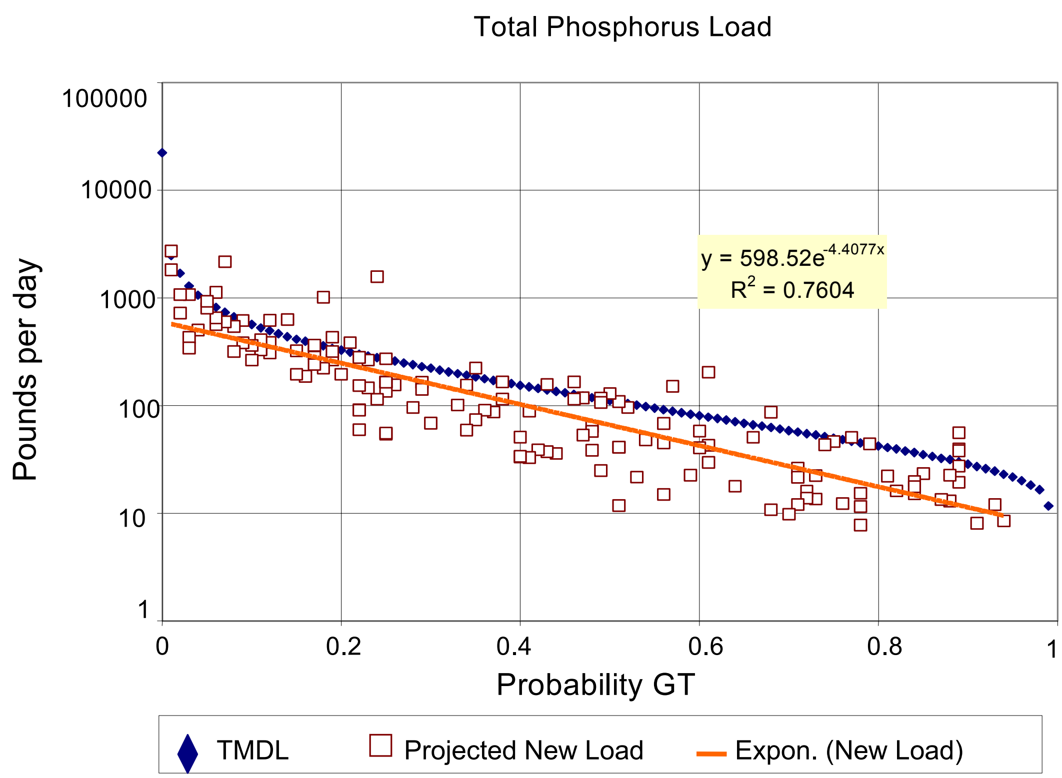
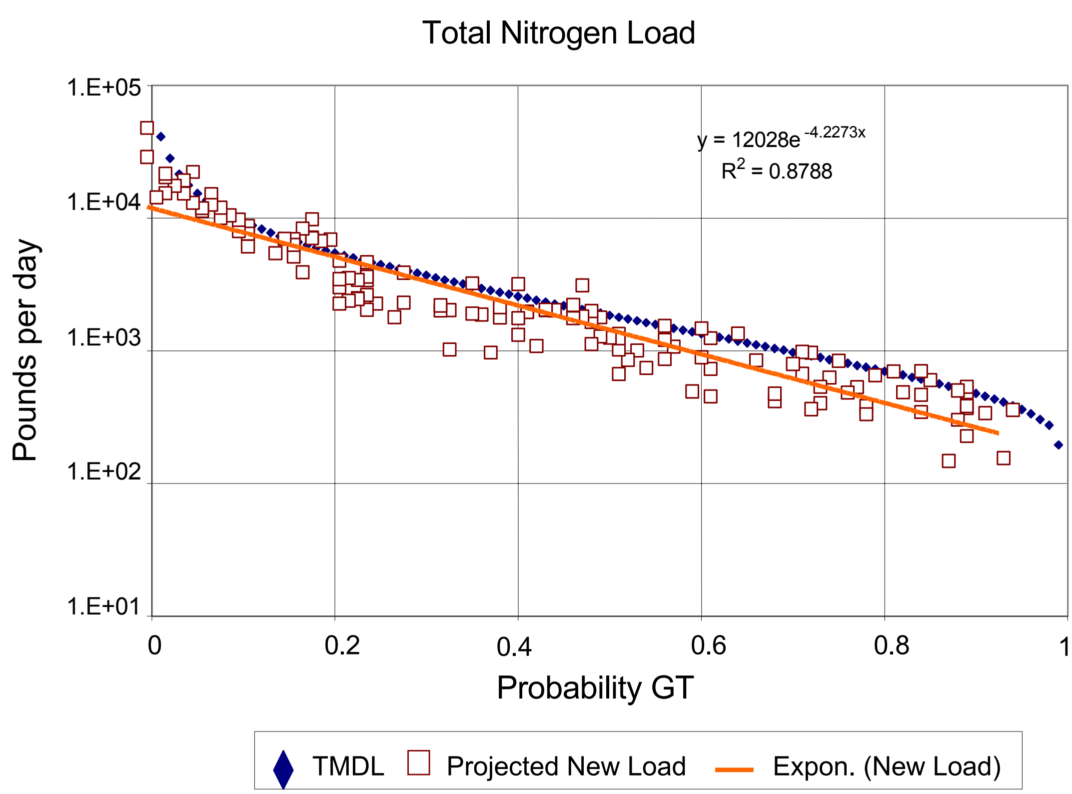


Figure 5: Total Nitrogen Reduction at Different Flow Ranges



Information from the department's Southwest Regional Office indicates that the number of animals being produced in the Missouri portion of the watershed may be experiencing a decline. A concern expressed by local citizens is that population growth in the watershed is causing more agricultural land to be converted to housing development. One of the reasons for the population growth is the Wal-Mart Headquarters that is located in Bentonville, Arkansas. As the Wal-Mart Corporation continues to grow, more jobs are available at the company's headquarters. A new building to house the corporation's computer operations was recently constructed in McDonald County in Missouri. The federal government has identified McDonald County, Missouri, as part of the metropolitan Bentonville, Arkansas, area. A major concern of citizens is that the nutrient problem currently influenced by poultry production may soon be replaced by a problem caused by human population and urbanization. Addressing the nutrient loading from wastewater treatment facilities via this TMDL will help prevent nutrient problems in the future due to population growth.

7.0 Margin of Safety

The Clean Water Act requires that each TMDL be established with a Margin of Safety (MOS). This requirement for a MOS is intended to account for uncertainty in available data or in the link between actual effects that controls will have on the loading reductions and the water quality of the receiving stream. The MOS for this TMDL is both implicit (through the use of conservative assumptions in the calculation steps) and explicit. A significant conservative assumption was made by using the 95th percentile of observed data within each flow range, instead of the mean or median; this will yield a larger percent reduction that ensures the TMDL target will be met. This percent reduction progressively shifts from the wasteload allocation to the load allocation as stream flow increases. An explicit MOS was created by the TP effluent limits for larger facilities, which will insure a load reduction of 10 percent below the TMDL requirement during base-flow conditions.

8.0 Seasonal Variation

Total phosphorus has the propensity to attach to sediment and remain in the system for an extended period of time. It may re-suspend and be available during the algae growing season. Because of these two characteristics, this TMDL should apply year round. The point source contribution is expected to be constant throughout the year. On the other hand, nutrient enrichment from nonpoint sources is very seasonal and depends to a large extent on the timing of agriculture activity (soil fertilization) and rainfall events. Spring is a critical period for nonpoint source loading because it has greater rainfall, it is the growing season for most crops and it is the time when pastures and fields are fertilized. If water quality standards are achieved during high spring flows, when nonpoint sources are the major contributor to loading, and during summer low flows, when point sources are the major contributor to loading, then they will be met year round.

9.0 Continuous Monitoring Plan using the Adaptive Management Approach

The objective of the monitoring program is to collect the necessary data on nutrient concentrations, suspended sediment load, algae production and stream flow to verify the appropriateness of the TMDL water quality targets. The monitoring program will also be used to track the success of nutrient reduction efforts as the TMDL is implemented.

The monitoring plan will be a continuation of the current monitoring plan. There are 25 monitoring stations strategically placed throughout the watershed (Figure B-2 and Table B-2, Appendix B). Although there is not historical data upon which to base a TMDL target for Buffalo and Patterson creeks, monitoring stations have recently been put in place in these two sub-basins. This will allow for the current target to be evaluated and altered in the future if the data indicates a need to do so. Department staff would like to run a Soil and Water Assessment Tool (SWAT) model on the watershed in the future to verify the results of the load duration curve and help determine the most cost effective way to implement nonpoint source controls by targeting high input areas. The locations of the current sampling sites may not be the most desirable for SWAT modeling, as they don't coincide with the natural drainage areas. The advantages of the current locations are that they are easily accessible and many have historic data and were the basis for the development of this TMDL.

The ADEQ has agreed to reinstate an inactive sampling site on the Little Sugar at the state line. This will help more accurately determine the nutrient loading from Little Sugar Creek in Arkansas. Data collection will include physical and chemical parameters such as pH, DO, temperature, BOD, turbidity, conductivity, flow, and the following nutrient parameters:

- Unionized Nitrogen Ammonia (NH_3 as N)
- Nitrogen as Nitrite + Nitrate (NO_2 + NO_3 as N)
- Total Kjeldahl Nitrogen (TKN)
- Total Phosphorus (TP)
- Dissolved Orthophosphate Phosphorus (Ortho P)

As funding allows, additional monitoring stations may be added to the Elk River continuous monitoring plan to further clarify the loading from sub-watersheds or to provide information that would allow for additional modeling efforts to verify the load duration curve used in this TMDL. After evaluation of the additional data produced by the continuous monitoring plan, Phase II of this TMDL may be used to revise the target concentrations or the implementation plans to better ensure the Elk River will meet water quality standards in the future.

10.0 Implementation Plan

The implementation plan documents current activities and provides information on future efforts that will ensure the Elk River meets Water Quality Standards after implementation.

10.1 Point Sources

All Missouri permitted facilities discharging to the Elk River watershed and having a design flow greater than or equal to 400,000 gallons per day (0.4 MGD or 0.62 ft^3/s) shall discharge no more than 1.5 mg/L TP as a maximum daily concentration nor more than 1.0 mg/L as a monthly average limit. These effluent limits shall apply to any new facility regardless of size. The same limit shall apply to existing facilities if they expand beyond their current design flow and the proposed design flow is equal to or greater than 22,500 gallons/day. Permit limits for new or expanded discharges are necessary, as the entire load capacity for the Elk River is being allocated by this TMDL and it does not include allowances for growth.

The timelines for implementing new limits and the appropriate compliance schedules will be determined by permitting staff on a case-by-case basis. Considerations will include when an existing permit is scheduled to be renewed, the actual volume of the discharge and the phosphorus concentration in the effluent. The overriding goal for the decision-making will be to achieve the greatest amount of phosphorus reduction in the most timely and cost effective manner.

All permits in the watershed will contain a monitoring requirement for total phosphorus and total nitrogen to provide further information regarding the nutrient concentration in individual effluents and to provide more accurate point source loading information. If a facility has a high phosphorus concentration in their effluent (greater than 5.0 mg/L), attempts must be made to reduce the TP in the discharge through better management practices at the treatment plant or through pre-treatment efforts targeted at the inputs that cause the increased concentration of phosphorus. If effluent concentrations remain high after management efforts have been made, permitting staff may choose to include nutrient limits in the permit regardless of the size of the discharge. This will prevent excessive loading of nutrients from any one facility and more fairly implement the nutrient reduction effort across all point sources.

At the proposed effluent flow (3.65 ft^3/s) and monthly average concentration of 1.0 mg/L, the Tyson Noel plant will discharge no more than a monthly average of 19 lb/day of total phosphorus. This TP load was derived by use of the following equation:

Future design flow x conversion factor x TP monthly average concentration = load
3.65 x 5.395 x 1.0 = 19 lb/day

The majority of the time, the Neosho Crowder wastewater treatment facility does not discharge to the Elk River basin and was therefore not included in the TMDL calculation. During normal flows, the effluent is piped to another treatment plant in Neosho before being discharged into the Shoal Creek basin. A permitted outfall, however, continues to exist in the Elk basin and may discharge under high flow conditions. If the City of Neosho chooses to maintain this potential discharge to the Elk basin, a discharge limit of 1.5 daily maximum of TP will be included in the permit. The alternative would be for the city to eliminate this outfall.

Currently, the ADEQ is adding TP limits to the permits of major discharges. The City of Bentonville falls into this category and they are moving toward the installation of phosphorus removal equipment. Concerns remain related to phosphorus loading from Bella Vista and Pea Ridge discharges, particularly in light of the population growth that is occurring and is predicted to continue. The University of Arkansas did a study in 2003 regarding the effectiveness of on-site septic systems in the Village of Bella Vista.[9] The study concluded that although increasing trends in some parameters of concern were noted, overall water quality in the area was good and on-site wastewater systems were viable and protective of water resources. Although the data may not show major impacts at this time, as the on-site systems age and potentially are not maintained, it is only a matter of time before the on-site systems make a significant contribution to the nutrient load in the Elk River. Missouri and Arkansas will continue to pursue resolution

[9] Williams, Rodney D. and Gross, Mark A., 2003. A Watershed Approach to Managing On-site Wastewater Systems. University of Arkansas, Department of Civil Engineering. Funded by a 319 Grant from the Arkansas Soil and Water Conservation Commission.

for the loading from point source discharges in Arkansas. Discussions have occurred locally regarding the possibility of establishing a sewer district and providing centralized wastewater treatment for the northwest Arkansas area. The ADEQ, however, has not been approached with any formal proposals regarding this issue. One possibility for encouraging local decision-making would be for Missouri DNR, ADEQ and the Elk River Watershed Improvement Association to hold a joint public meeting in the Little Sugar Watershed in Arkansas to increase awareness of the issue and obtain public input into possible solutions. The ultimate goal will be to achieve equitable and consistent policies regarding phosphorus removal from point source discharges throughout the watershed.

10.2 Nonpoint Sources

Efforts to reduce loading from nonpoint sources will be achieved on a voluntary basis. It should be noted, however, that land application of animal waste could be a source of nutrient loading if the application is not done properly. Land application of poultry litter requires a permit issued by the State of Missouri. The permit specifies the manure be applied at agronomic rates, which should result in a no discharge system because the nutrients are taken up by plants. The permit addresses other issues, such as the slope of land and when the animal waste should be applied to reduce the possibility of runoff. If the permit conditions are not followed and nutrient runoff occurs, it can result in enforcement action being taken by the department.

The provision of funding to cost share on the installation of best management practices (BMPs) is one of the most effective ways to ensure reductions in loading from nonpoint source runoff. To this end, the Water Pollution Control Program issued a Section 319 Request for Proposals targeted at the Elk River Watershed in 2001. As a result, three grants were funded. The following describes each of the grants.

1. The McDonald County Soil and Water Conservation District, in conjunction with the Natural Resources Conservation Service, received an allotment of $645,763 from the FY01 grant for a water quality restoration project. The total project cost that will be provided by 319 funding is estimated to be $1,258,596. The project period is from July 2002 – June 2006. The objectives of this grant are:
   - To develop Comprehensive Nutrient Management Plans (CNMPs) on 100 farms (about 15,000 acres) to prevent over application of nitrogen and phosphorus to soils.
   - To record the amount of litter that is being applied according to CNMPs in the watershed.
   - To increase nutrient uptake on 6,000 acres under CNMPs by correcting soils with a pH below 5.8, thus reducing nutrient runoff.
   - To construct 24 manure storage sheds to enable proper timing of nutrient application and prevent uncovered outside storage of litter. This will allow approximately 326 tons of nitrogen and 326 tons of phosphate per year in the litter to be managed properly so risk of runoff into waterbodies is reduced. To reduce runoff from 100 tons of litter per tarp (10 tarps) so litter can be temporarily stored in close proximity to an area that is in need of the nutrients. This will aid in management of 2.5 tons of nitrogen and 2.5 tons of phosphate/tarp/use. The tarps will be used in a watershed not listed for nutrients on the 303(d) list.
   - To demonstrate the feasibility of transporting 3,200 tons of litter containing approximately 80 tons of nitrogen and 80 tons of phosphate out of the watershed.

- To protect streams from sedimentation and fecal contamination from livestock on 20 farms or 5 miles of stream.
- To construct wells to supply water for managed grazing systems when this is the least cost and most environmentally beneficial option for livestock drinking water.
- To hire a project coordinator, technician and clerk to accomplish the above objectives.
- To contact landowners with current animal waste plans for review and update to CNMPs on 50 farms.
- To promote the goals and successes of the Elk River/Shoal Creek Water Quality Restoration Project to the media and to the public through the current Elk River Water Quality Demonstration Section 319 Project.
- To participate with stakeholders in the watersheds (interested citizens, governmental agencies, industrial, agricultural, urban and watershed organizations, etc.) in development and implementation of two water quality management plans.
- To aid in quantification of the nutrient problem in the watershed through compilation of soil and litter analyses.
- To provide progressive photographic documentation of all tasks listed in milestones. At minimum this would include "before and after" photos of installation of best management practices.
- To quantify the reduction in nutrient loading in the Elk River and Shoal Creek Watersheds due to this Section 319 project.

To date, this project has completed:

- 75 Comprehensive Nutrient Management Plans (CNMPs) for 9,439 acres
- 38 follow-up visits to farms with CNMPs
- Built 10 stacking sheds
- Approved cost share for 27 stacking sheds
- Two landowners have agreed to install practices that will restrict livestock access to streams
- Approved cost-share for pH correction of acidic soils on 469 acres
- Conducted field days, written articles, received press coverage and participated in public meetings to help educate the public on water quality issues

2. A Section 319 grant was awarded to University of Missouri Outreach and Extension. The total project award was for $277,973. The total project cost is estimated at $468,831. The objectives of the grant are:
    - Accelerate the adoption of BMPs by local landowners to control nutrient run-off.
    - Increase landowner awareness of environmental concerns from poorly located or constructed on-site sewage systems.
    - Conduct educational classes, informational meetings and demonstration/field days on water quality management planning, manure management and on-site sewage systems.
    - Provide the course "Environmental Assessment for Real Estate Professionals."
    - Form watershed alliance groups.
    - Assist in the development of water quality management plans.

    Products from this grant include:

    - Development and implementation of at least two water quality management plans
    - Six educational classes to identify best manure management practices and accelerate their adoption

- Four classes entitled "Environmental Assessment for Real Estate Professionals"
- Eight meetings to educate landowners on proper maintenance and management of on-site sewage systems
- A "resource notebook" which will compile educational resources of water quality information
- Six demonstration sites and field days to educate producers and landowners about water quality issues
- Project brochure highlighting project goals and objectives
- Reproduction of informational guides to promote BMPs
- Pre/Post Surveys to show increased awareness and perception of the project goals

An accomplishment of this grant has been assisting with the establishment of the Elk River Watershed Improvement Association. The mission of the organization is "To improve, protect and conserve waters within the Elk River watershed." The adopted vision statement for the group is "Clean abundant water for you and your family now and in the future." The watershed association is currently drafting by-laws. One goal for the group is to expand on the Watershed Restoration Action Strategy (WRAS) developed under a previous 319 grant effort. Beyond the identified nutrient impairment, local citizens have also expressed concern regarding bacteria levels, sedimentation, gravel mining and littering. The culmination of past and present 319 grants will be to produce a comprehensive Watershed Management Plan for the Elk River. One of the workshops "Environmental Assessment for Real Estate Professionals" has been provided and attendees received 6 hours of continuing education credit for participating in the workshop.

3. A Section 319 grant for $257,460 was awarded to the Department of Natural Resources' Environmental Assistance Office (EAO). This grant intends to demonstrate open air composting of poultry litter at Neosho High School and at the University of Missouri Southwest Research Center. The project period is April 2002 - April 2006. Objectives of this grant are:
   - Demonstrate and create interest in composting, which is an economically feasible and environmentally friendly way of managing litter where the traditional method of land spreading poses a threat to water quality.
   - Show that composted litter is safer and more easily managed than raw manure and litter.
   - Develop markets for composted litter.
   - Provide an environmentally friendly method of using waste sawdust, wood chips or other carbon sources.
   - Create a sustainable synergy between poultry producers and end users of the composted litter.
   - Increase awareness in the general public of the impact of poultry litter in the watershed and desirable ways of mitigating the impact.

   Products from this grant include:
   - Poultry compost demonstration pads at each site constructed of concrete, clay or lime
   - Composted poultry litter
   - Tours of the compost facilities
   - Demonstrations on composting to school children
   - Neosho High School students trained in the operation of the compost facility
   - Newsletters to poultry producers and general citizens in the watershed about composting
   - Field days to demonstrate composting

- Inserts that will accompany the compost when it is sold
- Educational day featuring compost as a value-added product
- A brochure to explain the composting process along with the environmental and economic benefits
- A Quality Assurance Project Plan (QAPP)

The compost pads are currently under construction at the Mt. Vernon site, to be followed by construction of pads at the Neosho site. The bid has been accepted for the composting equipment that will move on-site after the construction is complete. Both sites will be actively composting by the spring of 2004.

A previous 319 grant was awarded in 2000 to the Southwest Missouri Resource Conservation and Development (RC&D) Council for $454,400. The total cost of the project was projected to be $841,300. This grant is funded through June 2004. The grant states the following objectives:

- Assess nitrogen, phosphorus, potassium, and other nutrient levels in soil in the watershed. Test soils on an estimated 1,500 farms.
- Coordinate with the DNR water quality testing sites in watershed.
- Improve poultry litter nutrient management.
- Develop guidance materials for utilizing litter-stacking shelters.
- Expand networking between growers, litter haulers and landowners.
- Increase successful working septic systems.
- Improve riparian corridor management.
- Increase use of grazing and watering systems to improve livestock/pasture management.

Products of this grant include:

- Demonstrate four (4) poultry litter stacking shelters
- Provide two (2) litter hauling seminars
- Demonstrate six (6) grower nutrient management sites
- Demonstrate two (2) septic system maintenance/clean-outs
- Develop three (3) riparian corridor repair and management sites
- Demonstrate three (3) livestock and pasture management systems

Accomplishments of this grant to date include:

- A Watershed Restoration Action Strategy (WRAS)
- A QAPP for soil and manure sampling and analysis
- Development and distribution of surveys
- Cooperative agreements for stacking shelter demonstrations
- Nutrient management video
- Elk River brochure
- Six Poultry Litter Field Days
- Five grower meetings
- Two riparian corridor management workshops
- Two livestock/pasture management field days
- One litter haulers workshop
- One stacking shelter field day

Exportation of litter out of the watershed is one of the proposed solutions for reducing the nutrient loading in the Elk River. A major problem in exporting litter is that raw litter cannot be easily transported or stored. A proposed solution to this problem is the incineration of poultry litter to produce energy. A Section 319 grant has been approved for funding in FY 2004 that will demonstrate the use of incinerators on individual farms. Poultry litter will be used as fuel to heat production houses and reduce energy costs for the producer. The 319 funding awarded for this grant is $454,400 and the total cost of the grant is estimated to be $788,000. The details on this grant will be available once the subgrant amendment supporting this project completes the final approval process.

Another opportunity exists to use poultry litter from the Elk basin at a near-by Superfund Site in Jasper County, Missouri. Center Creek and Turkey Creek, near the City of Joplin, are listed as impaired by lead. This is due to the legacy of the lead mining that occurred in the area at the turn of the century. A multitude of tailings piles of various sizes exist in these watersheds. Although the remediation plan has not been finalized, one of the options includes creating soil that will sustain vegetation on small tailings piles or on the footprints of large tailings piles that have been reburied or had the chat otherwise utilized. Stabilizing these sites with vegetation will prevent further runoff of sediment containing high levels of lead, cadmium and zinc. Demonstration projects using various materials to create a media or "soil" that will support plant life have been completed. One of the most promising demonstrations that produced a high diversity of plants is soil generated from sewage sludge and poultry litter. The sewage sludge is from wastewater plants that remove phosphorus from their discharge and produces sludge high in phosphorus. Poultry litter also has a high phosphorus content and can enhance the growth of vegetation. Phosphorus is usually the limiting nutrient for growth of vegetation in mined areas.

A possible adjunct to implementation could be local governments passing ordinances that would encourage development to occur in areas where infrastructure, including centralized wastewater treatment, is readily available. This would reduce the need for additional discharges in the basin and it would prevent the proliferation of on-site septic systems. An additional benefit could be the prevention of piecemeal conversion of agricultural and forestland into urban land use as the population continues to increase.

In 2003, the Arkansas Legislature passed three bills addressing concerns with the poultry production industry. House Bill 1652, known as the Arkansas Soil Nutrient Management Planner and Applicator Certification Act, requires a certification system to be developed for people who write nutrient management plans. The bill also requires the development of a nutrient applicator training and certification program for poultry litter haulers and other fertilizer applicators. House Bill 1653, known as the Arkansas Poultry Feeding Operations Registration Act, requires all poultry producers to register annually with the Arkansas Soil and Water Conservation Commission. The purpose of the Act is to accurately quantify the amount of litter being produced and to encourage the proper utilization of the litter. When this information becomes available it will improve the implementation of the TMDL and verify the information contained in this document. House Bill 1654, known as the Arkansas Soil Nutrient Application and Poultry Litter Utilization Act, requires limits on the application of nutrients and regulates the utilization of poultry litter to protect certain areas while maintaining soil fertility. It specifies the nutrient surplus watersheds to which the Act applies and includes the Little Sugar Creek Watershed. The Arkansas Soil and Water Conservation Commission is charged with implementing these bills. Contracts are currently in place to develop the Phosphorus Index for

Arkansas and Oklahoma and to develop appropriate application rates for nutrients. A contract is also in place for the development of the rules that will implement the House Bills cited above. A draft of the information regarding rulemaking and implementation provisions for these acts is scheduled to be made available in 2004. As the implementation of these laws progress, it should reduce the nutrient loading in the Little Sugar Watershed from nonpoint sources in Arkansas.

Staff of the Benton County Soil & Water Conservation District have reported that 16 poultry facilities in the Arkansas portion of the Little Sugar Watershed currently have litter management plans in place.

Figure 3 (Reference and Existing TN Loads Measured at Tiff City) indicates most of the TN loading that causes an exceedence of the TMDL target occurs during higher flows. This trend is consistent throughout the period of record. This indicates that nitrogen coming from nonpoint sources is a concern when trying to address the total nitrogen load in the Elk River. Nonpoint source efforts utilizing BMPs to reduce total phosphorus loading should also result in the desired reductions in total nitrogen loading.

11.0 Reasonable Assurance

Local citizens generate the best solutions for remediating problems that exist within a watershed. The progress made by the Elk River Watershed Improvement Association provides a large measure of assurance that water quality concerns will be addressed now and into the future. The association is open to participation by citizens from Oklahoma, Arkansas and Missouri. This provides a balanced approach that takes into consideration all interests within the watershed. The development of watershed management plans by local residents will enhance the effort to decrease nutrient loading. Additionally, the group will address other water quality concerns that are important to local citizens. These include issues such as bacteria levels, gravel mining, failing on-site septic systems and population growth. Local residents expressed these concerns on a survey disseminated at the first public meeting. The formation of an active watershed partnership is the best assurance that anti-degradation, as required by the Missouri Water Quality Standards, will be achieved within the Elk River Watershed.

Funding opportunities for best management practice implementation provides reasonable assurance that the load allocation target will be met. There are requirements and conditions that must be met in order to receive these funds and that also provides assurance that the nonpoint source target load will be achieved. Possible sources of funds include:

- 319 Nonpoint Source Grants and 319 Minigrants
- Soil and Water Conservation Program Grants
- Farm Bill Environmental Quality Incentive Program (EQIP) Funds
- State Revolving Funds (SRF) for Nonpoint Sources
  (specifically for on-site septic financial assistance)
- Community Development Block Grants
- EPA Environmental Justice Grants
- Department of Economic Development Funds

The inclusion of permit limits for total phosphorus ensures nutrient loading reductions from point sources in Missouri. The Missouri Department of Natural Resources will consider innovative suggestions for achieving the desired phosphorus loading from point sources discharging into the Elk River Watershed. This includes consideration of proposals for pollutant trading between point sources.

Example:
A small municipality wants to expand their discharge and cannot obtain funding to install phosphorus removal equipment at their wastewater treatment plant in a timely manner. They also have concerns regarding the expertise, cost and maintenance required to achieve a total phosphorus permit limit. If another permittee in the watershed has already implemented phosphorus removal, the community may wish to pay the owner of the existing treatment system to reduce their inputs to a level that would compensate for the community's inability to reduce their own loading. This would be most effective when the existing TP removal system utilizes chemical addition for treatment.

An advantage to a total phosphorus effluent limit of 1.0 mg/L monthly average is that it can be attained through chemical addition or biological treatment. Biological treatment may be more cost effective for some facilities. Biological treatment also requires less maintenance and reduces the on-going cost of purchasing chemicals. Reduced costs for treatment should result in phosphorus removal being implemented more quickly.

The Consent Judgement with Tyson Foods will assure implementation of total phosphorus permit limits and specified reductions in nutrient loading coming from the Noel processing plant. The plant has implemented phosphorus removal in advance of the compliance schedule contained in the Consent Judgement. Another condition of the consent decree is Tyson has agreed to ensure Nutrient Management Plans are developed for all contract growers and Tyson owned or managed poultry farms located in Missouri that provide birds to the Noel plant. This provides further assurance that nonpoint source loading will be reduced in the watershed.

On-going, cooperative efforts between Arkansas and Missouri will achieve an equitable solution to nutrient loading from point and nonpoint sources. The Governors of Missouri and Arkansas will sign a Memorandum of Agreement regarding water quality issues in the near future. This agreement is to solidify the working relationship between the two states. Two watersheds are specifically mentioned as locations where this agreement will apply. They are the White River and Elk River Watersheds. Issues addressed by the agreement include:

- Cooperation in the development of monitoring and modeling efforts in the Elk River and White River Watersheds
- Sharing of monitoring data
- Identification of water quality studies and projects to be conducted on a bi-state basis, including timelines for implementation
- Meet annually to review progress toward goals
- Report annually on the progress to the Governor's of both states

The Arkansas legislation described earlier also provides reasonable assurance that nonpoint source loading from Arkansas will be reduced in the future. The number and dollar amounts of Section 319 grants awarded in the Missouri portion of the Elk watershed provides reasonable assurance that the nonpoint source loading in Missouri will be reduced. The increase in Farm

Bill monies available through the EQIP that is available in both states also provides further reasonable assurance that agricultural nonpoint source inputs will be addressed through utilization of cost share for BMPs.

12.0 Public Participation

This water quality limited segment is included on the approved 1998 303(d) list for Missouri. Public meetings were held around the state and a public comment period was provided to give citizen's input into the 303(d) list. The Missouri Department of Natural Resources, Water Pollution Control Program, developed this TMDL.

Monthly public meetings regarding the water quality issues in the Elk River watershed have been held since April of 2003. The goal of these meetings has been to get public input on the TMDL and encourage the development of watershed management plans for the Elk River. As a result of these meetings, the Elk River Watershed Improvement Association has been formed. The awareness of the nutrient water quality issues has been greatly enhanced by these meetings.

This TMDL document was placed on public notice for December 5, 2003 to January 4, 2004. Groups that receive the public notice announcement include:

- Elk River Watershed Improvement Association
- The Missouri Clean Water Commission
- The Water Quality Coordinating Committee
- The TMDL Policy Advisory Committee
- Stream Team volunteers in the watershed
- Appropriate legislators
- Arkansas Department of Environmental Quality
- Arkansas Soil & Water Conservation Commission
- Oklahoma Department of Environmental Quality
- Oklahoma Water Resources Board
- Others that routinely receive the public notice of Missouri State Operating Permits

Any comments received during the public notice period will be incorporated into the TMDL as appropriate. A copy of the notice, the comments received and the department responses may be found in the Elk River Docket maintained within the department.

13.0 Administrative Record and Supporting Documentation

- Crowder College data
- U.S. Geological Survey data
- Missouri Department of Natural Resources data
- ADEQ data and Waste Load Allocation for Bentonville
- 2003 Arkansas House Bills addressing poultry production
- Survey responses from the public concerning water quality issues in the Elk River
- Copy of Consent Judgement with Tyson Foods
- Copies of Missouri Section 319 Grants awarded in the Elk River Watershed
- Copies of all Missouri Permits in the Elk River Watershed
- Public Notice announcement
- Elk River Information Sheet
- Elk River Watershed Restoration Action Strategy
- Water quality studies that have been conducted in the Elk River basin (See Appendix C)

14.0 References

Chapra, Steven C. 1997. Surface Water-Quality Modeling. WCB McGraw-Hill.

Ditoro, Dominic M. 2001. Sediment Flux Modeling. John Wiley & Sons, Inc., Publication.

Sharpley, A.N., T. Daniel, T. Sims, J. Lemunyon, R. Stevens, and R. Parry. 1999. Agricultural Phosphorus and Eutrophication. U.S. Department of Agriculture, Agricultural Research Service, ARS-149, 42pp.

Steel R. and James H. Torrie, Principal and Procedures of Statistics. 1980 McGraw-Hill.

Texas Natural Resources Conservation Commission (TNRCC), Developing Total Maximum Daily Load Projects in Texas. August 17, 1999.

U.S.D.A. National Agricultural Statistical Service. Census of Agriculture. http://www.nass.usda.gov/census/

U.S. Environmental Protection Agency. 1999. Protocol for Developing Nutrient TMDLs. EPA 841-B-99-007. Office of Water (4503F), United States Environmental Protection Agency, Washington, D.C. 135 pp.

USGS: United States Geological Survey. Water Resources of Missouri. http://mo.water.usgs.gov/

Williams, Rodney D. and Gross, Mark A. 2003. A Watershed Approach to Managing Onsite Wastewater Systems. University of Arkansas, Department of Civil Engineering. Funded by a 319 Grant from the Arkansas Soil and Water Conservation Commission.

Appendix A

Table A-1: Number of Poultry in Elk River Watershed

Average Number of Animals					
Missouri:	**1974, 1978, 1982**	**%**	**1987, 1992, 1997**	**%**	**Percent Change**
Layers & Pullets	1,374,974		2,021,281		47%
Broilers	1,448,198		6,076,460		320%
Turkeys	35,077		171,369		389%
Sub-total	2,858,249	23%	8,269,110	33%	189%
Arkansas:					
Layers & Pullets	1,253,043		1,925,331		54%
Broilers	8,182,511		14,788,913		81%
Turkeys	154,360		368,442		139%
Sub-total	9,589,914	77%	17,082,686*	67%	78%
Total:	12,448,163	100%	25,351,796	100%	104%

* Recent information obtained from staff of the Benton County Arkansas Soil and Water Conservation District indicates that poultry production in Benton County is not evenly distributed at this point in time. The majority of the poultry production is located south of the Little Sugar watershed in the Eucha/Spavinaw Watershed. Staff provided estimates of the actual number of birds in the Arkansas portion of the Little Sugar Watershed in 2003 and that information is included in the table below.

Poultry Operations in the Little Sugar Watershed as Reported by the Benton County Soil and Water Conservation District

Number of Operations	Type of Operation	Total Yearly Production
8	Broilers	2,614,000
5	Turkeys	511,000
2	Cornish Hens	1,400,000
1	Breeder Hens	24,000
1	Pullets	60,000
Total: 17 Operations		Total: 4,609,000 Birds

The total number of birds contained in the table above is lower than numbers derived by back calculating from the National Agricultural Statistical Service (NASS) countywide data contained in Table A-1. The purpose of Table A-1 is to compare poultry production pre- and post-1985. The recent information from the Benton County Soil and Water Conservation District does not alter the conclusion drawn from the data above. Poultry production in northwest Arkansas and southwest Missouri has increased dramatically since 1985 and has been determined to be a major source of the nutrient loading in the Elk River watershed. Table A-1 was created using the best available data from the NASS for comparing historic levels of poultry production to levels of production over the last 20 years.

Table A-2: Hog Farming in the Elk River Watershed

Average Number of Animals					
	1974 – 1985	**%**	**1986 – 1997**	**%**	**Percent Change**
Missouri:					
Barry	2,779		496		-82%
McDonald	34,307		43,083		26%
Newton	2,226		328		-85%
Sub-total	39,312	7%	43,907	71%	12%
Arkansas:					
Benton	540,141	93%	17,682	29%	-97%
Total:	579,452		61,589		-89%

Table A-3: Cattle Farming in the Elk River Watershed

Average Number of Animals					
	1975 – 1985	**%**	**1986 – 1998**	**%**	**Percent Change**
Missouri:					
Cattle & Calves	87,371		77,586		-11%
Beef Cows	37,420		37,006		-1%
Milk Cows	4,876		1,832		-62%
Sub-total	129,667	78%	116,424	77%	-10%
Arkansas:					
Cattle & Calves	33,577		28,894		-14%
Beef Cows	N/A				
Milk Cows	2,388		5,938		149%
Sub-total	35,965	22%	34,832	23%	-3%
Total:	165,632	100%	151,255	100%	-9%

Table A-4: Letters of Approval for Animal Waste Management Systems in Missouri

County	**Poultry Broilers** AU*	**Poultry Dry Litter Systems** AU*	**Poultry Layers** AU*	**Turkey** AU*	**Dairy** AU*
Barry	1,331,800	20,000		38,500	
McDonald	2,659,250	82,800	108,600	38,500	100
Newton	1,305,400	39,000		658,024	270
Watershed Total:	**5,296,450**	**141,800**	**108,600**	**735,024**	**370**

*1 Animal Unit (AU) = 100 Poultry Broilers
60 Pullets
30 Layers
55 Turkeys
0.07 Dairy Cow

Figure A – 1: Map of Permitted CAFO's in Missouri Portion of Elk River

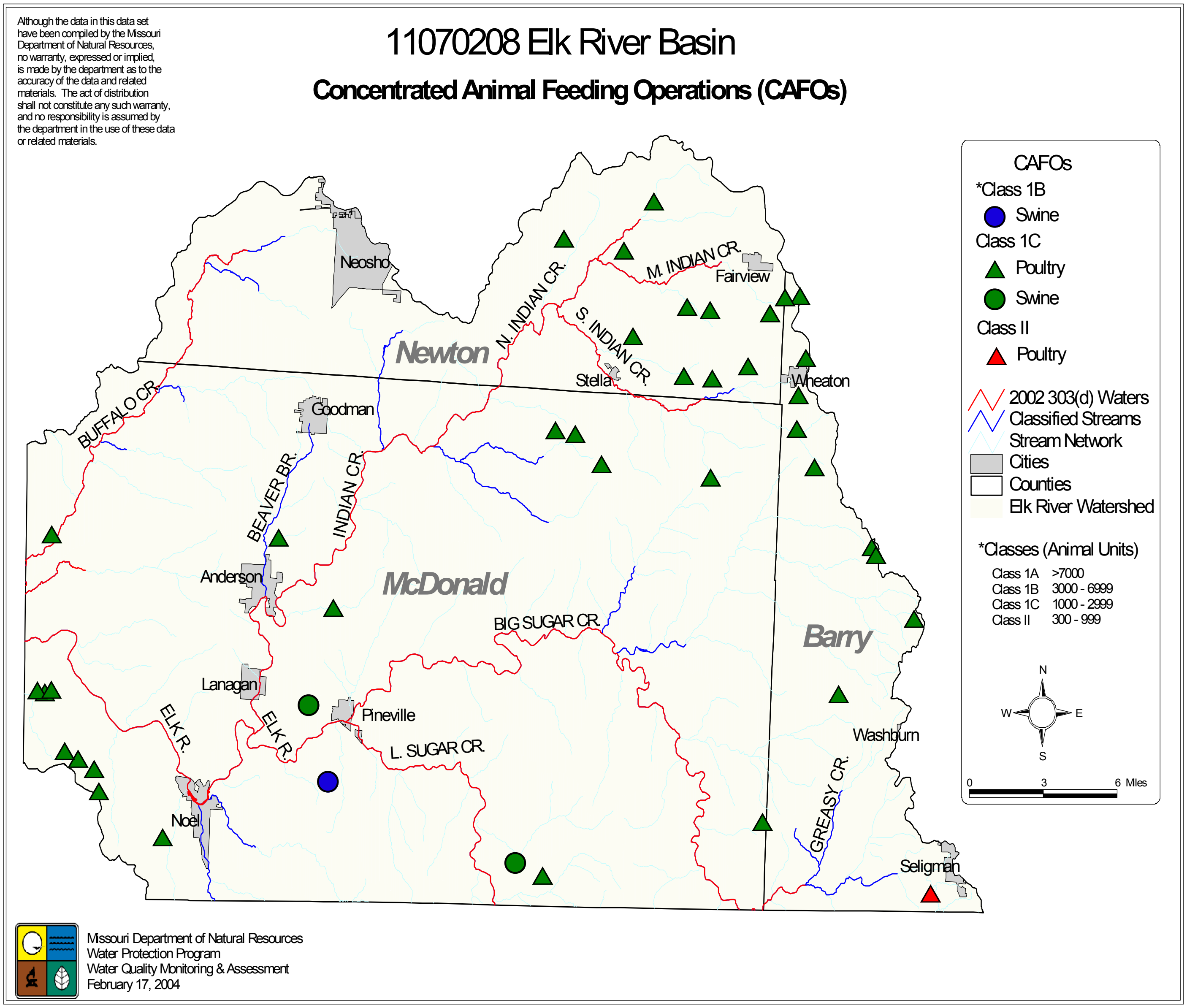


Table A-5: Flow duration table for base flow, local minimum method at Elk River near Tiff City, MO 1940-2002 (partial output)

	Cases equal or exceeding lower limit and less than upper limit		Cases equal or exceeding lower class limit	
Lower Class Limit	Cases	Percent	Cases	Percent
0	0	0	23011	100
3.9	0	0	23011	100
4.5	2	0.01	23011	100
5.2	10	0.04	23009	99.99
6	9	0.04	22999	99.95
6.9	23	0.1	22990	99.91
7.9	11	0.05	22967	99.81
9.1	19	0.08	22956	99.76
10	6	0.03	22937	99.68
12	3	0.01	22931	99.65
14	3	0.01	22928	99.64
16	3	0.01	22925	99.63
18	22	0.1	22922	99.61
21	15	0.07	22900	99.52
24	48	0.21	22885	99.45
28	76	0.33	22837	99.24
32	86	0.37	22761	98.91
37	115	0.5	22675	98.54
43	136	0.59	22560	98.04
49	486	2.11	22424	97.45
57	609	2.65	21938	95.34
66	632	2.75	21329	92.69
75	886	3.85	20697	89.94
87	892	3.88	19811	86.09
100	1273	5.53	18919	82.22
120	581	2.52	17646	76.69
130	1130	4.91	17065	74.16
150	1556	6.76	15935	69.25
180	925	4.02	14379	62.49
200	1287	5.59	13454	58.47
230	1338	5.81	12167	52.87
270	1219	5.3	10829	47.06
310	1271	5.52	9610	41.76

Figure A-2: Confidence Interval Band (95percent) around the regression line of ln (load)* probability flow for observed loads within base flow range (0 – 250 ft^3/s)

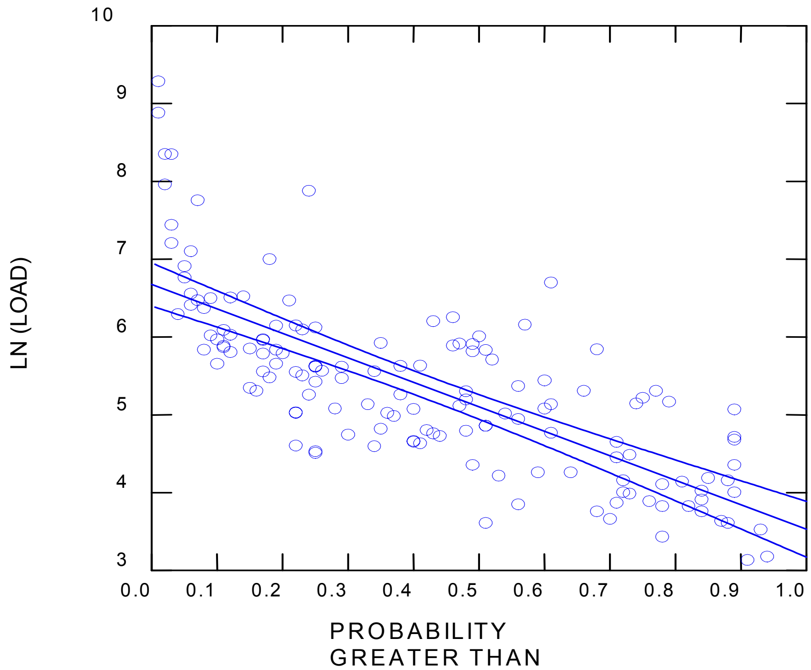
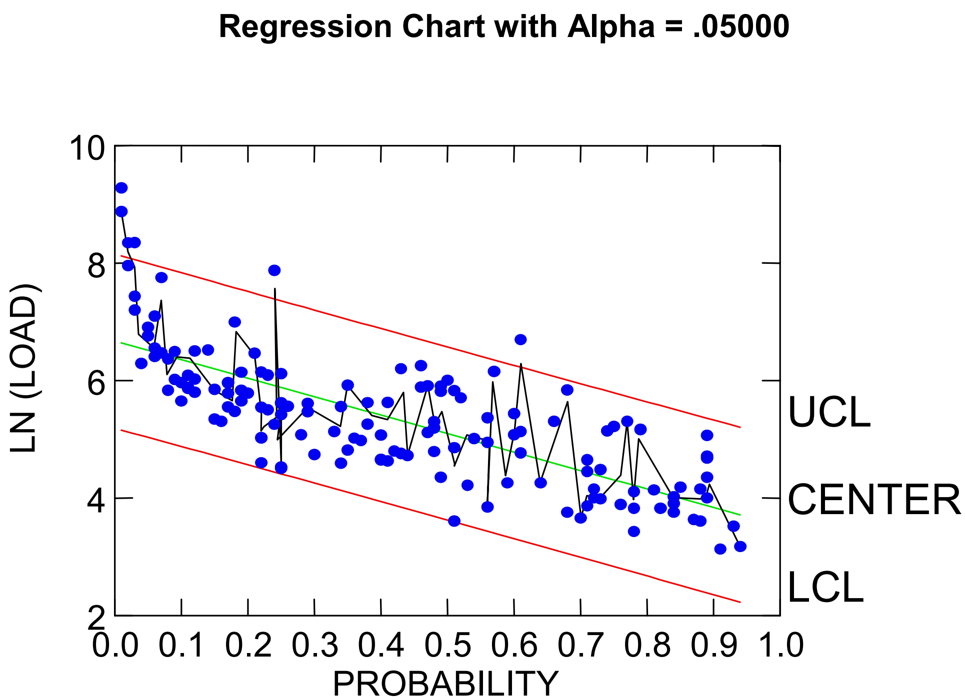


Figure A-3: Prediction Intervals for Individual ln (load) estimate for observed loads within base flow range (0 – 250 ft^3/s)



Appendix B

Figure B-1: Land Use Classification and Distribution in the Watershed

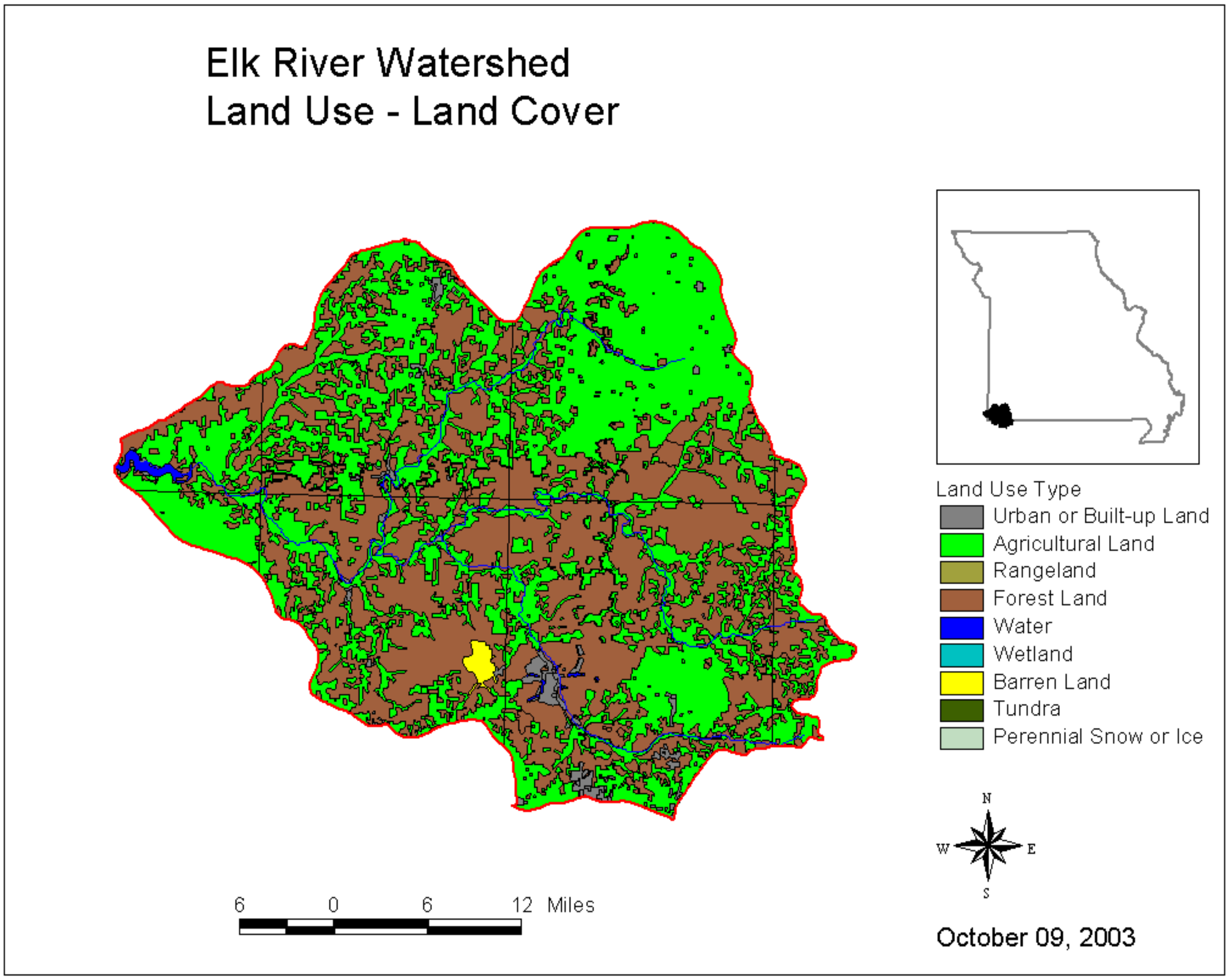


Table B-1. Detailed Information on Land Use Distribution within the Elk River Watershed

Land Use Name and Code	Area (acres)
Urban or Built-up Land	
RESIDENTIAL-11	9,384
COMMERCIAL AND SERVICES-12	1,545
INDUSTRIAL-13	99
TRANS, COMM, UTIL-14	347
MXD URBAN OR BUILT-UP-16	345
OTHER URBAN OR BUILT-UP-17	843
Subtotal	12,563
Agricultural Land	
CROPLAND AND PASTURE-21	321,870
CONFINED FEEDING OPERATIONS-23	1,687
OTHER AGRICULTURAL LAND-24	192
Subtotal	323,749
Forest Land	
DECIDUOUS FOREST LAND - 41	314,690
EVERGREEN FOREST LAND-42	4,876
MIXED FOREST LAND-43	2,554
Subtotal	322,120
Water	
RESERVOIRS-53	2,531
Subtotal	2,531
Barren Land	
TRANSITIONAL AREAS-76	2,488
Subtotal	2,488
Total	**663,451**

Figure B-2: Existing Monitoring Sites

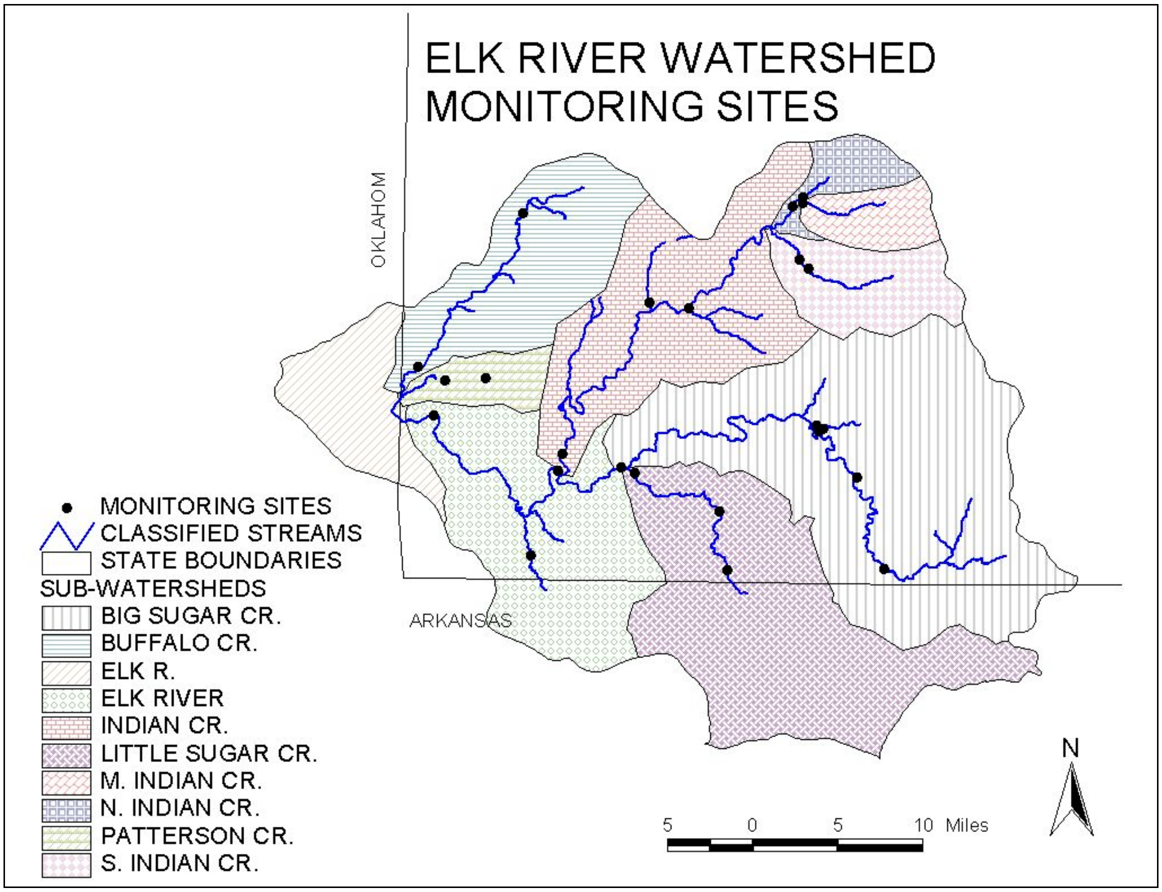


Table B-2: Existing Monitoring Sites in the Elk River Watershed within Missouri

SITE_ID	SITE_NAME	WBID	CLASS	LAT	LONG
3259/3.8	S. Indian Cr. @ Stella	3259	P	36.75990	-94.19250
3247/2.5	Butler Cr. nr. Sulfur Springs, AR	3247	P	36.51222	-94.48167
3268/2.7/3.3	Patterson Cr. 2.8 mi. above Hwy 43	3268	U	36.66250	-94.53167
3260/2.0	N. Indian Cr. just below M. Indian Cr.	3260	P	36.81200	-94.21050
3250/33.8	Big Sugar Cr. nr. Jacket	3250	P	36.50500	-94.10890
3250/24.9/0.1	Trent Cr. nr. Mouth	3250	U	36.58290	-94.13820
3250/19	Big Sugar Cr. @ Hwy E	3250	P	36.62150	-94.18010
3254/0.2	Mike's Cr. nr. Mouth	3254	P	36.62630	-94.18170
3246/20.8	Elk R. @ Pineville	3246	P	36.58840	-94.38750
3246/14.7	Elk R. just below Indian Cr.	3246	P	36.58490	-94.45470
3246/1.9	Elk R. @ Tiff City	3246	P	36.63060	-94.58680
3273/5.2	Buffalo Cr. nr. Dessa	3273	P	36.80310	-94.49500
3269/1.2	Buffalo Cr. @ Tiff City	3269	P	36.67080	-94.60430
3268/2.7/0.5	Patterson Cr. @ Hwy 43	3268	U	36.66040	-94.57540
3260/3.0	N. Indian Cr. just above M. Indian Cr.	3260	P	36.82060	-94.19910
3262/0.3	M. Indian Cr. nr. Mouth	3262	P	36.81560	-94.28290
3259/3.3	S. Indian Cr. nr. Stella	3259	P	36.76690	-94.20250

3257/0.2	Elkhorn Cr. nr. Mouth	3257	P	36.72430	-94.31850
3264/0.5	Bullskin Cr. nr. Mouth	3264	P	36.72870	-94.36040
3256/1.8	Indian Cr. @ Lanagan	3256	P	36.59930	-94.44980
3249/12.5	Little Sugar Cr. @ Caverna	3249	P	36.50220	-94.27430
3249/7.7	Little Sugar Cr. nr. Jane	3249	P	36.55200	-94.28290
3249/0.7	Little Sugar Cr. @ Hwy K	3249	P	36.58400	-94.37340
3254/1	Mike's Cr. nr. Mouth	3254	P	36.62340	-94.17530

Appendix C

Elk Basin Water Quality Studies:

- A Hydrologic Investigation to Determine the Extent of Septic Tank System Contamination of Little Sugar Creek in Missouri by the Bella Vista Development, Benton County, Arkansas, Missouri Department of Natural Resources, Clean Water Commission, 1975. Study evaluated whether septic tank systems in Bella Vista Development were contributing to water quality degradation in waters flowing into Missouri. The conclusion was that the many septic tanks in the Bella Vista subdivision were affecting springs in the area.
- A Watershed Approach to Managing On-site Wastewater Systems, Rodney Williams and Mark Gross, Dept. of Civil Engineering, University of Arkansas, 2003. Funded by the Arkansas Soil and Water Conservation Commission and focused on Bella Vista Village. This study concluded that although increasing trends in some parameters of concern were noted, overall water quality in the area was good and on-site wastewater systems were viable and protective of water resources.
- Intensive Survey Report, Missouri Department of Natural Resources, Division of Environmental Quality, Laboratory Services Program, July 1982 through October 1982. The purpose of this study was to obtain background data on the stream prior to construction of a new wastewater treatment facility at Noel, Missouri.
- Survey of Missouri's Rural Wells: McDonald County, Sievers, Dennis M., Charles D. Fulhage, Special Report 440, Agricultural Experiment Station, College of Agriculture, University of Missouri-Columbia, June 1992. This study examined water quality in private wells and two natural springs.
- Buffalo Creek Stream Survey, Missouri Department of Natural Resources, Division of Environmental Quality, Laboratory Services Program, August 1983. This study was a part of the wasteload allocation study to determine stream conditions and effects of the Neosho Municipal Waterwater Treatment facility during low flow conditions. Study concluded that the plant was causing some adverse affects.
- The Movement of Shallow Groundwater in the Camp Crowder Area, Newton County, Missouri, Vandike, James E., and Cynthia Brookshire, Missouri Department of Natural Resources, Division of Geology and Land Survey, 1996. Study focused on dye tracing in springs and losing streams in the Camp Crowder area.
- Nutrients and Pesticides in Ground Water of the Ozark Plateaus in Arkansas, Kansas, Missouri and Oklahoma, James C. Adamski, Water-Resources Investigations Report 96-4313, U.S. Department of the Interior, U.S. Geological Survey, 1997. An examination of randomly selected springs and private wells, two land use studies, and a small watershed study in the Ozark Plateau region.
- Elk River Sportfish Survey, Missouri Department of Conservation, July 1998. This study was undertaken as a result of citizen complaints that the fish community in Elk River was nonexistent. This small study compared current populations with populations found in a study in 1982.
- Water Quality Assessment of the Ozark Plateaus Study Unit, Arkansas, Kansas, Missouri and Oklahoma—Fish Communities in Streams and Their Relations to Selected Environmental Factors, Petersen, James C, Water-Resources Investigations Report 98-4155, U.S. Department of the Interior, U.S. Geological Survey, 1998. This study examined physical, chemical and biological factors in fish populations in the Ozark Plateau.

- Water Quality Assessment of the Ozark Plateaus Study Unit, Arkansas, Kansas, Missouri and Oklahoma—Nutrients, Bacteria, Organic Carbon, and Suspended Sediment in Surface Water, 1993-95, Davis, Jerri V., and Richard W. Bell, Water-Resources Investigations Report 98-4164, U.S. Department of the Interior, U.S. Geological Survey, 1998. This study examined nutrients, bacteria, organic carbon and suspended sediment samples from 43 sites in the Ozark Plateaus study unit from 1993-1995.
- Water Quality in the Ozark Plateaus: Arkansas, Kansas, Missouri and Oklahoma, 1992-1995, Peterson, James C., James C. Adamski, Richard W. Bell, Jerri V. Davis, Suzanne R. Femmer, David A. Freiwald, and Robert L. Joseph, U.S. Geological Survey Circular 1158, U.S. Department of the Interior, U.S. Geological Survey, 1998. This publication examined stream and groundwater contamination by nutrients, bacteria, pesticides, mine drainage, radiation and other factors affecting fish communities and aquatic habitat.
- Elk River Watershed Inventory and Assessment, Rick Horton, Missouri Department of Conservation, December 1999. This study examined geology, land use, hydrology, water quality, habitat conditions, biotic community and management aspects of the Elk River basin.
- Interim Report: Statistical Summary of Grand Lake Data, Geoffrey A. Canty, Oklahoma Conservation Commission, Water Quality Division, December 1999. This interim study identified and monitored critical areas of pollutant loading to Grand Lake. No conclusions were drawn.